Appendix 1

Governor's Brown Cloud Summit Subcommittee Processes and Recommended Control Measures

Background

In July 2000, the Brown Cloud Summit established five subcommittees. The Inventory Technical Advisory Group (ITAG) was charged with recommending to the other Subcommittees the emissions inventories to be used by the Subcommittees and the Summit in their deliberations on control strategies, and to provide a method for evaluating strategies. The On-Road Mobile Controls, Off-Road Mobile Controls, and the Stationary and Area Source Controls Subcommittees were charged with evaluating the effect of existing and future emissions controls and recommending additional strategies that would result in improved visibility in the Phoenix area. The Visibility Standards Subcommittee was established to evaluate options for a visibility standard or other method to track progress in improving visibility in the Phoenix area.

ITAG

Members of ITAG included technical representatives of the following Summit members: John D. Ford, Edward Z. Fox, Supervisor Andrew Kunasek, Victor Mendez, Jerry Moyes, Mayor Skip Rimsza, Kevin Rogers, Supervisor Sandie Smith, Charlie Stevens and Richard W. Tobin II. Richard M. Hayslip was appointed by Summit Chairman Ed Phillips as ITAG Chairman.

In its deliberations to develop baseline and out year inventories for use in the Subcommittees' evaluation of control strategies, ITAG used existing and well-understood data sets. For the base year emission inventory, several regional PM_{10} inventories including the MAG 1990, 1994 and 1995 inventories, as well as the 1996 U.S. Environmental Protection Agency's National Emissions Trends (NET) Inventory, were considered. The ITAG agreed on the use of the 1995 MAG emission inventory, along with the use of County-level emissions estimates for $PM_{2.5}$ and PM_{10} from the NET inventory to ensure completeness.

One of the other key data sets considered by ITAG was the MAG projected emission inventory for the year 2006. This inventory uses a variety of methods to forecast what emissions might be, including EPA's MOBILE5 emissions model for on-road mobile sources, and surrogate information like population and employment for area and point sources. This inventory accounts for all measures committed to in the Phoenix nonattainment area toward compliance with the PM10 standard. The ITAG agreed that emissions reductions associated with contingency measures that have been implemented should be included, along with some estimate of emissions reductions attributable to the national Tier 2 program for on-road sources. Finally, ITAG agreed the milestone years for the control measures analysis to be 1995, 2003, 2006, 2010, 2015, and 2020.

ITAG spent considerable time in developing an appropriate tool for use by the Subcommittees to evaluate the visibility impacts of the various control measures. Initially, ITAG reviewed the Integrated Assessment System (IAS), which had been used by the Grand Canyon Visibility Transport Commission for this same purpose. ITAG concluded that the IAS itself could not be utilized by the Summit for several reasons, including the inability to disaggregate emissions data for Maricopa County. ITAG voted, with two abstentions, to direct The Kendall Group to develop a prototype spreadsheet that would rely on the approach used in the IAS, but tailored for use by the Summit.

Utilizing a rollback approach, the assessment tool included a baseline forecast emission inventory with committed and existing measures, a retirement factor, a method to grow new sources, a particle to visibility impairment method, an emissions to particle concentration method, and the reductions associated with a control measure.

The prototype developed included two summary pages for each measure to show the effects of the control measure on the 20% worst winter days and an annual average day, in deciviews. The summary pages also include the calculation of costs per deciview change.

On-Road, Off-Road, and Stationary and Area Source Subcommittees

The subcommittees considered the following sources to identify possible control measures which may reduce visibility impairment.

- Report of the Governor's Air Quality Strategies Task Force, Feb. 1998
- The 1999 Brown Cloud Project for the Maricopa Association of Governments --Recommendation Measures
- Clark County/Las Vegas, NV area measures
- Portland, OR (primarily ozone controls) area measures
- Seattle/Puget Sound, WA area measures
- Washoe County/Reno, NV area measures
- South Coast Air Quality Management District, CA area measures
- State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials (STAPPA/ALAPCO) Controlling Particulate Matter Under the Clean Air Act: A Menu of Options
- Report of the Grand Canyon Visibility Transport Commission to the US EPA
- San Francisco Bay Area Ozone Attainment Plan (June 1999)
- South Coast Air Quality Management District 1999 Amendments to 1997 Ozone Attainment Plan (Dec. 1999)
- Texas Natural Resource Conservation Commission - Houston/Galveston Ozone Attainment Plan (Aug 2000)

The list was screened in order to eliminate duplicate strategies, control measures already implemented in the Phoenix Metropolitan area, voluntary programs which have been implemented, and federal regulations which have been implemented or will be in the future.

The control measures initially considered by the Subcommittees are provided in Table 1.1. The list of potential control measures was then prioritized by a semi-quantitative ranking system similar to the one used by the Grand Canyon Visibility Transport Commission. The criteria for review of each measure included: the effectiveness in achieving visibility goals, economic effects, social effects, environmental effects in addition to visibility, equity, and administrative ease and effectiveness. A scoring and ranking process was used to narrow the potential measures down for more detailed research and analysis.

The refined list contained 26 measures for analysis with the ITAG visibility assessment tool (Table 1.2). Specific information for each measure was provided, including: inventory sectors affected, the time for implementation, estimated capital and maintenance cost, and estimated reduction in pollutants.

These data were used as input for the visibility assessment tool which resulted in estimates of visibility change and annualized cost for each potential control measure. Ultimately, the Subcommittees recommended potential control strategies for further consideration by the Summit. Detailed information regarding the measures is available in each Subcommittee Final Report.

Members of the On-Road Mobile Controls Subcommittee were: Representative Carolyn Allen (Vice-Chairwoman), Richard L. Boals, Victor Dugan, John D. Ford, Jerry Moyes, Norm Petersen, Charlie Stevens, and Richard W. Tobin, II. Bob Lavinia was appointed by Summit Chairman Ed Phillips as the On-Road Mobile Controls Subcommittee Chairman.

Members of the Off-Road Mobile Controls Subcommittee were: Tim Boncoskey, Representative Leah Landrum, Skip Martinkivoc, Bill Pfeifer, Dan Pollard, and Kevin Rogers. Ed Fox was appointed by Summit Chairman Ed Phillips as the Off-Road Mobile Controls Subcommittee Chairman.

Members of the Stationary & Area Source Subcommittee were Summit members: Senator Linda Aguirre, William Foley (alternate Bert Gumeringer), Supervisor Andrew Kunasek (alternate Steve Peplau), Victor Mendez (alternate Pat Cupell), P.A. Seitts, Supervisor Sandra Lee Smith (alternate Donald Gabrielson). Anne Wendell was appointed by Summit Chairman Ed Phillips as the Stationary & Area Source Subcommittee Chairwoman.

Visibility Standard Subcommittee

The Subcommittee recommended the use of achievable interim "blue sky" visibility targets until a daily visibility index value is selected using a public process for the metropolitan area by the end of 2003. The Subcommittee also recommended the continued use of the existing visibility monitoring network with additional monitors to track progress. A detailed report of the Visibility Standard Subcommittee's work and recommendations are contained in Appendix 3.

Control Measures

The following tables provide a listing of the control measures considered by the Subcommittees, modeled and ultimately recommended for consideration by the Summit. The Summit adopted all of the control measures recommended by the Subcommittees with the following modifications:

- Truck Bypass and Speed Restriction on Poor Visibility Days - Safety concerns related to the speed restriction resulted in the removal from that provision from the control measure.

- Voluntary Early Implementation of Ultra-Low Sulfur Diesel for use in On- and Off-Road Diesels Retrofitted with Oxidation Catalysts and Particulate Filters - The Summit is recommending a combined control measure which provides for voluntary introduction of ultra-low sulfur diesel and retrofit controls based on the off-road control measure adopted by the Summit on December 12, 2000, and the on-road control measure recommended by the On-Road Mobile Controls Subcommittee and adopted by the Summit on December 5, 2000.

- NOx Reduction Systems - At the November 29, 2000, meeting the Summit agreed to merge this measure with the Clean Fleet and Equipment Program.

- Controls for Stationary Reciprocating Internal Combustion Engines - This measure was removed as it is redundant because of the 500 ppm sulfur fuel requirement for Area A (Arizona Revised Statutes 41-2083(J)).

Table 1.1 Control Measures Initially Considered by the Subcommittees	
1	Voluntary Vehicle Repair and Retrofit Program Funding (Light Duty Gas Vehicles)
2	Voluntary On-Road Diesel Repair and Retrofit Program
3	Mandatory Adoption of CARB Diesel
4	Full Implementation of Roadside Diesel Testing
5	Arizona's Adoption of California Not To Exceed (NTE) Standards
6	Vehicle Idling Restrictions
7	Voluntary Early Implementation of Ultra-Low Sulfur Diesel for Use in Diesels Retrofitted with Diesel Oxidation Catalysts and Diesel Particulate Filters for Public Fleets
8	Truck Bypass and Speed Restriction on Poor Visibility Days
9	Moratorium on Siting Truck Stops
10	Implement a Toll-Free Telephone Number for Smoking Vehicle Complaints
11	Implement a Smoking Vehicle Identification and Citation Program
12	Diesel Retrofits with Gaseous Fuel Enrichment Systems (propane)
13	Strengthen the Voluntary On-road Diesel Engines and Equipment Retirement
14	Voluntary Vehicle Recycle Program (Light Duty Gasoline Vehicles)
15	Emissions Banking
16	Electrify Truck Stops Through a Pilot Program
17	Encourage Private Industry to Provide Effective Programs and Incentives to Enhance Trip Reduction
18	Implementation of the California Low Emission Vehicle (LEV) Program in Arizona
19	Implement a Inspection and Maintenance (IM) Program Enforcement to Detect and Test for Smoking Vehicles or Particulate Matter High Emitters
20	Reformulated (CARB) Gasoline All Year
21	Vanpool - Transportation Demand Management
22	Diesel Emulsions
23	Closed School Campuses
24	Biodiesel and Other Diesel Fuel Alternatives
25	Provide TRP Credits to Employers for Encouraging Employees to Live closer to Work and Assisting Employees with Purchase of New and/or Alternative Fueled Vehicles
26	Registration Enforcement
27	Bicycle Measure: Bicycling Facilities and Policies
28	Voluntary Visibility Trading Program with Backstop Cap and Trade Program
29	Mandatory Adoption of CARB Diesel
30	Mandatory NOx Reduction Systems
31	Voluntary Accelerated Purchase of Tier 2/Tier 3 Diesel Equipment
32	Voluntary Diesel Retrofit Program for State and Local Contracts
33	Voluntary Replacement of Airport Ground Support Equipment
34	Expand Area A: 18 - 20 miles around the urban center
35	Expand Area A: statewide
36	California Spark-Ignition Engines

Table 1.1 Control Measures Initially Considered by the Subcommittees	
37	Extension and Expansion of the Voluntary Lawn Mower and Lawn Equipment Replacement Program
38	Mandate the Use of Electric Golf Carts
39	Diesel Emulsion
40	Construction Equipment Operating Restrictions
41	Lawn Service Equipment Operating Restrictions
42	Reformulated (CARB) Gasoline All Year
43	Voluntary Early Implementation of Ultra-Low Sulfur Diesel for use with Oxidation Catalysts and Particulate Filters for Public Fleets
44	Blue Sky Program
45	Ban Leaf Blowers
46	Additional Funding for PM_{10} Efficient Street Sweepers
47	Replace Generators with Electrical Power at Construction Sites
48	Increase Funding for County Inspection and Dust Control Program
49	Dust Control Training For Contractors
50	Expansion of Area A
51	Air Quality Alert Days
52	Controls for Stationary Reciprocating Internal Combustion Engines
53	Require Natural Gas for Electricity Generation
54	Emissions Cap and Trading Program
55	Government Funding for Water/Pre-Watering Activities
56	Reduce BACT Trigger for New and Modified Sources to 10 lb./day
57	Require Road Shoulder Stabilization
58	Control for Boilers and Gas Turbines-Industrial, Commercial, Institutional Units and Electric Utilities
59	Just-in-time Clearing for Construction Projects
60	Restrictions on Commercial Fireplaces and Restrictions on Residential and Commercial Fire Pits
61	Ban Used Oil Burning
62	Alternatives to Land Clearing by Burning
63	Operational Control on Leaf Blowers
64	Dust Palliative Tax Incentive
65	Transfer State Authority for Portable Sources to the Counties
66	Additional Emission Reductions from Consumer Products
67	Incentivize/Require the Conversion of Wood Burning Fireplaces/Stoves
68	Architectural coating rule - STAPPA
69	CARB-like Standards for Consumer and Architectural Coatings
70	Energy Efficiency for Buildings
71	Residential & Commercial Air Conditioning Units to Reduce Ozone
72	Retrofit if Not Operating New Technology
73	Reduction of Existing Opacity Standard
74	Development of Opacity Coupon for Contractors to Use
75	Alternative to Expanding Area A is to Create Area C

Table 1.2 Control Measures Evaluated with the ITAG Assessment Tool	
1	Voluntary Vehicle Repair and Retrofit Program Funding (Light Duty Gas Vehicles)
2	Voluntary On-Road Diesel Repair and Retrofit Program
3	Adopt Reformulated Fuel Standards: CARB Diesel - on-road
4	Full Implementation of Roadside Diesel Testing
5	Arizona's Adoption of California's Not To Exceed (NTE) Standards
6	Combination of Three Diesel Retrofit Measures
7	Vehicle Idling Restrictions
8	Voluntary Early Implementation of Ultra-Low Sulfur Diesel for Use in Diesels Retrofitted with Diesel Oxidation Catalysts and Diesel Particulate Filters
9	NOx Reduction Systems - on-road
10	Truck Bypass and Speed Restriction on Poor Visibility Days
11	Accelerated Purchase of Tier 2/3 Engine Standard for Off-Road Diesel Equipment
12	Emission Banking
13	Inventory and evaluate diesel equipment and identify upgrade options
14	Equipment retrofit for state and local contracts
15	Adopt CARB diesel - off-road
16	Encourage replacement of off-road diesel engines & engine equipment
17	Airport Ground Support Equipment
18	NOx Reduction Systems - off-road
19	Ban Leaf Blowers
20	Additional Funding for PM_{10} Efficient Street Sweepers
21	Replace Generators with Electrical Power at Construction Sites
22	Increase Funding for County Inspection and Dust Control Program
23	Dust Control Training For Contractors
24	Expansion of Area A
25	Air Quality Alert Days
26	Controls for Stationary Reciprocating Internal Combustion Engines

	Table 1.3 Control Measures Recommended by the Summit	Page
Long Term Control Measures		
1	Long Term Cap and Trade Visibility Program	9
Short Term Control Measures		
2	Voluntary Vehicle Repair and Retrofit Program Funding (Light Duty Gas Vehicles)	10
3	Voluntary On-Road Diesel Repair and Retrofit Program	12
4	Full Implementation of Roadside Diesel Testing	14
5	Arizona's Adoption of California Not To Exceed (NTE) Test Procedures	16
6	Vehicle Idling Restrictions	18
7	Truck Bypass on Poor Visibility Days	20
8	Voluntary Accelerated Purchase of Tier 2/Tier 3 Diesel Equipment	21
9	Clean Fleet and Equipment Program with State and Local Contract Incentives	23
10	Voluntary Replacement of Airport Ground Support Equipment	26
11	Ban Leaf Blowers	28
12	Additional Funding for PM10 Efficient Street Sweepers	30
13	Replace Generators with Electrical Power at Construction Sites	31
14	Increase Funding for Maricopa and Pinal Counties Inspection and Dust Control Program	33
15	Dust Control Training For Contractors	34
16	Expansion of Area A	36
17	Air Quality Alert Days	37
18	Mandatory Adoption of CARB Diesel (on- and off- road)	39
19	Voluntary Early Implementation of Ultra-Low Sulfer Diesel for use in On- and Off-Road Diesels Retrofitted with Oxidation Catalysts and Particulate filters.	42

Long Term Control Measures

One measure, a backstop cap and trade program, was identified by the Subcommittees as a long-term visibility improvement program. The overarching concept can encompass a wide variety of control strategies, including those recommended as short-term measures discussed in Section 2.

1. Title: Long-Term Cap and Trade Visibility Program

Description and Background

This measure would establish a backstop emissions banking program for Maricopa County source categories with periodic declining emissions goals. The goals can be based on either visibility improvement or emission reductions. This measure as proposed is linked to the Visibility Standard Subcommittee's concept to develop a visibility improvement index for the Phoenix area.

The concept of a backstop visibility trading program is partially based on the Western Regional Air Partnership (WRAP) Cap and Trade Program. Market-based strategies, like the national approach to control the air pollution that causes acid rain, and the Western states' recommendations for a program to reduce haze at parks and wilderness areas, can be effective in reducing pollution levels at about 60% of the cost of traditional, regulatory programs. The program could begin in the 2004 to 2006 time frame, with the first target being one that affected sources can meet voluntarily. If the visibility improvements or reductions in air pollution are not met, a backstop cap and trade program would automatically begin that would set a cap on emissions of particulates and oxides of nitrogen, to ensure that targets are met. Businesses and industries that could most cost-effectively reduce emissions would get "credits" for reducing emissions more than they needed to, which they could sell to other businesses and industries that did not have opportunities for making cost-effective emissions reductions. Trading of emission reduction credits would help reduce the cost of meeting the pollution reduction goals. At its December 5, 2000, meeting, the Summit recommended legislation establishing a board of affected members of the public to design and oversee this approach, as well as authority and funding for ADEQ to develop and operate the program.

Effectiveness and Cost

The effectiveness could be, in part, determined by the voluntary nature of the program; however, the existence of a "backstop" and need to stay within an established target should increase participation and certainty of reductions.

Most of the cost of the program is in administration for outside contractor(s) to conduct equipment inventories, audits, manage emissions records, and possibly, the bank.

Section 2
Short Term Control Measures

The remaining control measure identified by the Subcommittees and adopted by the Summit (See Table 1.3) include a mix of short term voluntary and mandatory control measures. These include programs that could begin early as 2001 and others that would sunset in 2006.

2. Title: Voluntary Vehicle Repair and Retrofit Program Funding (Light Duty Gas Vehicles)

Description and Background
This measure would provide funding for repair or installation of emission upgrade kits on high-emitting light duty gasoline vehicles. The measure would apply in Area A and affects the gasoline vehicle exhaust sector. The measure could be implemented in FY 2002. In 1999, about 91,000 vehicles between 1967-1988 model years failed the State's Vehicle Inspection / Maintenance (I/M) test. Up to 20% of those vehicles, or 18,000, never completed the emissions test cycle (did not comply with the emissions standards or did not acquire a waiver). Further, the initial test emissions of the "disappearing" vehicles are significantly higher than those that complete the test cycle.

Maricopa County Environmental Services Department (MCESD) has a voluntary vehicle repair and retrofit (VVRR) program in Area A to provide vehicle owners with the option of voluntarily repairing or retrofitting their high-emitting vehicles with newer technology and better maintained vehicles. Emission upgrade kits are available on a voluntary basis to the "worst polluting" vehicles failing the inspection/maintenance test. The success of the program over the last two years indicates it is accepted in the community and is being smoothly implemented.

The existing VVRR program received appropriations from the Arizona Legislature of $640,000 in 1999 and $2 million in 2000/2001. Arizona's fleet is, on average, older than other parts of the country, so it's reasonable to assume there will be a continued demand for such a program.

To continue the program, MCESD would need additional funding from the Arizona Legislature. In Fiscal Year 2002, Maricopa County estimates that they would be able to use up to $1.6 million per year, essentially doubling the annual number of vehicles currently being retrofitted and repaired.

Following are suggestions to bring more vehicles into the VVRR Program in order to meet emissions requirements and reduce pollution:
- Additional funding on a permanent basis
- Additional repair facilities (5 authorized now recommend; 2 more for better coverage in the Valley)
- Additional staff to answer phone calls, coordinate and oversee repair facilities
- Signage at the emissions stations (posters, banners, sandwich boards)
- Information at auto parts stores
- Newspaper, radio or television advertising

Effectiveness and Cost

Vehicles that are accepted into the VVRR program have their emissions measured before and after repair using the IM147 test. The average emissions reductions from the repaired vehicles were 84% for hydrocarbons, 88% for carbon monoxide and 75% for NOx. It is estimated that this measure would reduce 32 tons of PM2.5 and 20 tons of NOx per year.

Through June 2000, for the Maricopa County area, 1,625 vehicles were repaired and 37 had retrofit kits installed. The average cost of repair per vehicle was $939. The cost of the program has been low relative to emission reductions.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	6.77	6.77	6.77	6.77	6.77
Change in Standard Visual Range (Km)	0.0	1.1	1.3	1.5	1.5	1.4
Haziness (Deciview Improvement)	0.00	0.44	0.47	0.50	0.51	0.49
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	1.60	1.60	1.60	1.60	1.60
Levelized Annual Total Cost ($ millions/year)						1.60
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	3.63	3.37	3.17	3.14	3.24

3. Title: Voluntary On-Road Diesel Repair and Retrofit Program

Description and Background

This measure would provide funding for installation of retrofit technology on heavy duty diesel trucks 1990 and older. The measure would apply in Area A and affects the diesel vehicle exhaust sector. The measure could be implemented in 2003 through 2006 (sunset in Year 2006). This measure reduces $PM_{2.5}$ through installation of retrofit technology (oxidation catalysts and/or particulate filters). This program would either parallel or enhance Maricopa County Environmental Services Department's (MCESD) already existing Voluntary Vehicle Repair and Retrofit Program for light duty gas vehicles. There is a provision for repair and retrofit of diesel vehicles under this program; however, MCESD reports that no diesel vehicles have been repaired or retrofitted under this program due to the high cost to the owners.

Arizona Revised Statutes § 49-474.03 authorized MCESD to implement a Voluntary Vehicle Repair and Retrofit (VVRR) program. Section D includes diesel vehicles > 8,500 GVWR registered in Area A that fail a random roadside testing program (which has not been implemented) as qualifying for the program. MCESD received appropriations of $640,000 in 1999 and $2 million in 2000/2001 from the Arizona Legislature to administer the program. The law places a limit of 20% of program funds that may be used for diesel vehicles.

Effectiveness and Cost

Using STAPPA/ALAPCO's report (1996) on diesel engine retrofits and engine rebuilds, a fleet of 1,000 trucks was used in the analysis of this control measure. PM_{10} emission reductions from six retrofit scenarios ranged from 25% to 75%. The following table lists the scenarios, percent of fleet covered, and potential PM_{10} emission reductions in Year 2010:

Table 1.1 - PM_{10} Retrofit Efficiency

Scenario	% PM_{10} Reduction	% Fleet Covered	PM_{10} Reduction in Year 2010*
1	25	10	1.6
2	25	50	7.8
3	50	10	3.1
4	50	50	15.5
5	75	10	4.7
6	75	50	23.3
*Percent Reduction from Year 2010 baseline based on hypothetical truck fleet			

Other studies have examined PM emission reductions from individual test diesel engines (not based on truck fleets). According to the DRI / McGraw Hill's report and the Manufacturers of Emission Control Association's Web site (http//www.meca.org), diesel particulate filters can reduce PM by 80% to 90% and diesel oxidation catalysts can reduce PM by 20% to 50%. These control devices appear to be most effective for pre-1991 diesels and work best with ultra low sulfur diesel fuel.

A similar technology is used in International Engine's "Green Diesel Technology" on some of their new diesel engine lines; this technology was demonstrated at the September 12, 2000, On-Road Subcommittee meeting (http//www.internationaldelivers.com). It is estimated that this measure would reduce 141 tons of $PM_{2.5}$ per year. Feasibility of this measure is reasonably high given the availability of the technology, but not optimal because the design does not specifically focus on high emitters. This control measure was evaluated assuming a 25% coverage of the applicable fleet and 75% reduction in emissions for each vehicle treated.

Diesel oxidation catalysts and diesel particulate filters have been in use in Europe for many years on a large number of diesel powered vehicles. In the 1993 DRI/McGraw Hill report, the cost of retrofitting diesel engines with a regenerating particulate trap was estimated to be in the range of $2,000 to $3,000 once this technology gained the benefit of large scale production (operating costs may be higher due to low sulfur diesel). Cost per ton basis, about $4,000 per ton PM reduced (particularly in the absence of cleaner diesel fuel) is relatively high compared to other measures.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010*	2015*	2020*
Light Extinction Improvement (1/Mm)	0.00	0.72	0.52	0.35	0.17	0.09
Change in Standard Visual Range (Km)	0.0	0.1	0.1	0.1	0.0	0.0
Haziness (Deciview Improvement)	0.00	0.05	0.04	0.03	0.01	0.01
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	1.00	1.00	0.00	0.00	0.00
Levelized Annual Total Cost ($ millions/year)						0.32
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	6.94	9.02	12.71	25.74	52.04

*Note: Measure scheduled to be sunset in Year 2006.

4. Title: Full Implementation of Roadside Diesel Testing

Description and Background

This measure would implement roadside testing of heavy duty diesel trucks in Area A and would affect the diesel vehicle exhaust sector. Legislative funding and regulatory authority for ADEQ is necessary to implement this program. Assuming legislative authority and funding is received in the Spring 2001 session, the necessary regulatory revisions could be finalized and the program implemented in January 2003. The program would be implemented through 2006. The program will be sunset in 2006 in order to reevaluate the program's effectiveness.

In 1996, EPA recommended that the SAE J1667 test be used in roadside diesel testing programs, and since then, several states have operated pilot and/or regulatory programs. As a result of a 1998 Task Force recommendation, the Legislature enacted SB 1427 in the regular 1998 Legislative Session. This bill authorized ADEQ to conduct a pilot roadside diesel test program, using the Society of Automotive Engineers (SAE) J1667, or snap idle, test for diesel vehicles with a GVWR $ 8,500 pounds. The goal of the program was to tabulate pass and fail rates and obtain registration and noncompliance information regarding failing vehicles in order to make recommendations for implementation of a permanent program.

However HB 2001, enacted in the December 1998 Special Session, directed ADEQ to reduce administrative expenses resulting in a reduction in force which eliminated the positions established to conduct the pilot roadside diesel test. This proposed measure would replace the authority to conduct pilot testing with a regulatory program.

A 1996 pilot program for the Greater Vancouver, British Columbia, area, was transitioned into a mandatory program in 1999 for heavy duty diesel vehicles. The Vancouver program consists of two, 2-person teams that patrol the region in mobile units capable of performing the SAE J1667 test on heavy duty diesel vehicles. Vehicles are pulled over to the roadside if they appear to be smoking excessively. The teams perform the SAE J1667 test to determine if the 55% opacity standard for 1990 and older engines and 40% opacity standard for 1991 and newer engines is being met. If not, the vehicle operator is given a notice that the vehicle must be fixed and reinspected within 30 days. A letter is also sent to the vehicle owner. The reinspection must be done at a qualified inspection facility. If necessary, follow-up letters are sent 30 and 60 days after the notice is issued, with the final penalty being a "refuse to issue" sanction. This means the owner will not be able to license or purchase insurance for the vehicle after the current license and insurance coverage period ends.

Effectiveness and Cost

Using modeling by Sierra Research, Inc., for the Vancouver program, ADEQ estimates a VOC reduction of 4.4% in 2003 and a $PM_{10}/PM_{2.5}$ reduction of 4.3% (80 tons of $PM_{2.5}$ / year). For the Vancouver program, initial program start-up costs in 1999 were $319,000 for two, 2-person mobile teams plus one full time coordinator. Annual program operating costs were estimated at $402,000. The cost to vehicle owners for the period May 1999 - February 2000 ranged from $50 (adjustment of AFR/AFC control on the injector pump) to $11,000 (engine overhaul), with the average cost of repairs at $821.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010*	2015*	2020*
Light Extinction Improvement (1/Mm)	0.00	0.14	0.09	0.06	0.03	0.02
Change in Standard Visual Range (Km)	0.0	0.0	0.0	0.0	0.0	0.0
Haziness (Deciview Improvement)	0.00	0.009	0.006	0.004	0.002	0.001
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	0.32	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.40	0.40	0.00	0.00	0.00
Levelized Annual Total Cost ($ millions/year)						0.18
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	19.70	29.12	41.19	74.13	152.61

*Note: Measure scheduled to sunset in Year 2006.

5. Title: Arizona's Adoption of California Not To Exceed (NTE) Test Procedures

Description and Background

This measure would mandate the adoption of California's Not To Exceed (NTE) Test Procedures for heavy duty diesel trucks statewide and would affect the diesel vehicle exhaust sector. The measure could be implemented by adopting California's rule for NTE test procedures for 2005 and 2006 model years. The California rule is expected to be final in 2001.

The U.S. EPA entered into a consent decree with seven major diesel engine manufacturers alleged to have employed defeat devices that turned off emission controls on over one million heavy-duty diesel engines. Emissions control devices were defeated during engine operating modes that are not represented in the federal heavy-duty diesel engine certification test (off-cycle modes). This caused significant excess emissions - 1.3 million tons of excess NOx emissions in 1998 alone.

In addition to monetary fines and environmental projects aimed at offsetting the excess emissions, these "Consent Decree" manufacturers agreed to conduct supplemental "not-to-exceed" (NTE) tests as part of their certifications to ensure emissions compliance throughout the engines' operating range. The agreement specified that the supplemental tests would be required for a period beginning in 2002 and ending in 2004.

To ensure continued emissions compliance, U.S. EPA planned to adopt the same supplemental requirements for 2004 and beyond. Due to extended technical negotiations with engine manufacturers, U.S. EPA was unable to finalize the rule in time for 2004 implementation. The Clean Air Act precludes EPA from providing less than four years of lead time for manufacturers, so the earliest feasible implementation date is 2005. On October 6, 2000, EPA finalized a rule (65 FR 59896) that requires post-sale NTE limits be met for MY 2007 and newer vehicles. This leaves a gap in the 2005 through 2006 model years for complying with the NTE standards.

Effectiveness and Cost

The measure can be very effective if Arizona and a majority of other states join California in adoption of NTE test procedures as noted earlier. The creation of a defacto national standard which compels manufacturers to produce and market a single line of engines/trucks that meet the standards will have the greatest effect and environmental benefit. All model year 2005 and 2006 heavy duty diesel vehicles sold and operated in this country would be cleaner operating under all engine operating modes, not just those operating modes represented in the federal certification test.

In its recent notice of public hearing for the proposed rule revisions, the California Air Resources Board (CARB) estimates excess NOx emission reductions at 8.4 tons per day in 2005 and 17.3 tons per day in 2006 from California registered vehicles. CARB states that the proposed test procedures may result in the need for some engine design modifications, which may have some cost ramifications that would most likely be passed on to the vehicle purchasers. However, since many manufacturers must meet similar standards before the two year lapse period of 2005 and 2006, most purchasers are not expected to experience a significant cost increase.

If all costs were passed onto the purchaser, an estimated maximum cost increase would be $674 per medium heavy-duty vehicle and $824 per heavy heavy-duty vehicle for model year 2005 vehicles. Average medium heavy-duty vehicle costs are $52,000; average heavy-duty vehicle costs are $108,000.

Based on the above NOx emission reductions, the cost effectiveness ranges from $0.63 to $0.09/lb of excess NOx reduced ($1,260 to $180/ton).

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.00	1.66	1.66	1.66	1.66
Change in Standard Visual Range (Km)	0.0	0.0	0.3	0.3	0.4	0.3
Haziness (Deciview Improvement)	0.0000	0.0000	0.1142	0.1212	0.1223	0.1189
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	54.90	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	-	-	-	-	-
Levelized Annual Total Cost ($ millions/year)						9.04
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	N/A	79.20	74.64	73.92	76.10

6. Title: Vehicle Idling Restrictions[1]

Description and Background

This measure would limit the idling time of heavy duty diesel trucks in Maricopa County. The measure would affect the diesel vehicle exhaust sector. An implementation date of 2003 was used for the assessment tool.

New York City traffic laws limit the idling time of heavy duty trucks to 3 minutes, year-round. The Texas Natural Resource Conservation Commission (TNRCC) proposed a similar measure as an ozone reduction measure. In TNRCC's measure, no person in the affected counties may cause, suffer, allow, or permit the primary propulsion engine of a heavy duty motor vehicle to idle for more than 5 consecutive minutes when the vehicle is not in motion during the time from April 1 through October 31. Discussions by the Summit concluded that the time limitation would need to be evaluated further for the Maricopa County area, but for assessment purposes, 5 minutes was used.

Effectiveness and Cost

Emission reduction numbers have been estimated as follows:

Heavy Duty Diesel Vehicle (HDDV) $PM_{2.5}$ exhaust contribution 1181.91 metric tons per year and 17512.58 metric tons per year NOx ("Table 2-2 1994 Maricopa County PM_{10} Nonattainment Area Emission Inventory Annual Totals by Inventory Components (metric tons per year)"). An average HDDV spends about one hour out of ten idling (Sysco, http://www.ccjmagazine.com/fuelcost.htm). Also a major grocery chain monitored their idle time on their delivery trucks and found that the trucks idled for about one hour out of ten working hours. The analysis assumes that about 75 percent of the trucks and buses which contribute to the 1181.91 metric tons per year have the 10 percent idle time per day, although the participation rate could be somewhere between 50 percent and 100 percent. The total would be less than 100 percent because part of the total fleet is composed of refrigerator trucks which must either be left running or be provided with a power source to run the refrigeration while loading/unloading.

1182 X 0.75 = 887 metric tons per year

Assuming that hourly idling emission and in-use emission are about equal, the idle contribution is about 89 metric tons per year.

An 80 percent reduction in idle emissions equates to 71 metric tons per year reduction in $PM_{2.5}$, or 6 percent. Applying the 6 percent reduction to NOx equals a reduction of 1,051 metric tons per year reduction in NOx.

TNRCC estimates the daily cost savings benefit of this strategy to be approximately $126,150 per ton of NO_x reduced. This figure was calculated by TNRCC from the estimated NO_x reductions, the estimated reduction in fuel consumption per hour, and the current price per gallon of fuel sold in the affected area.

[1]Under the leadership of Summit member, John Ford, excellent progress on working out the details for this measure had been made when the final report was adopted by the Summit. He estimated he could achieve consensus with stakeholder groups by the end of February 2001. Pending his efforts, the Summit recommended this measure, but did not take a position on whether it should be mandatory or voluntary.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.31	0.27	0.19	0.11	0.06
Change in Standard Visual Range (Km)	0.0	0.0	0.0	0.0	0.0	0.0
Haziness (Deciview Improvement)	0.00	0.0198	0.0184	0.0141	0.0078	0.0041
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	0.01	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.01	0.01	0.01	0.01	0.01
Levelized Annual Total Cost ($ millions/year)						0.01
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	0.59	0.63	0.82	1.50	2.81

7. Title: Truck Bypass on Poor Visibility Days

Description and Background

This measure would encourage heavy duty diesel trucks, light-duty vehicles, and medium-duty trucks traveling into the Phoenix area on Interstate 10 to use the Gila Bend bypass (State Route 85) on poor visibility days to avoid metropolitan Phoenix.

Effectiveness and Cost

Through traffic versus local traffic contributions to metropolitan Phoenix have been determined in an August/September 1999 origin-destination survey: for cars, 7% is through; for medium trucks, 15%, and for heavy trucks, 39%. Available bypasses for interstate traffic are limited to the Los Angeles-to-Houston route. No reasonable bypasses are available for the following routes: Globe to Los Angeles, Las Vegas to Tucson, and Flagstaff to points east, south, and west of Phoenix. Consequently, only 10% of the through traffic could take a bypass. Of this traffic, 25% of the cars and medium trucks and 50% of the heavy trucks might actually pay attention to a sign directing them out of the metropolitan area. The successful bypassing of this traffic would produce small decreases in the overall emissions of on-road gasoline and diesel emissions of fine particulates: 0.7% for gasoline and 1.8% for diesel particulates. If 100% of this traffic were diverted, then the figures increase to 1.7% for gasoline and 3.7% for diesel particulate.

The cost of the measure would be $764,000 for the purchase and installation of two variable message signs on the Los Angeles to Houston route (I-10, State Route 85, I-8, to I-10 – if eastbound), and $7,000 per year for operation and maintenance of the two signs.

Visibility Assessment Tool Results (Worst 20% Average Winter Day) - combined gasoline & diesel vehicles

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.68	0.44	0.33	0.22	0.20
Change in Standard Visual Range (Km)	0.0	0.1	0.1	0.1	0.0	0.0
Haziness (Deciview Improvement)	0.000	0.043	0.030	0.024	0.016	0.014
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	0.76	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.01	0.01	0.01	0.01	0.01
Levelized Annual Total Cost ($ millions/year)						0.13
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	3.06	4.44	5.53	8.08	9.44

8. Title: Voluntary Accelerated Purchase of Tier 2/Tier 3 Diesel Equipment

Description and Background
This measure encourages the voluntary accelerated purchase and operation of Tier 2 and Tier 3 off-road diesel equipment within Maricopa County.

This measure was originally proposed by the Texas Natural Resource Conservation Commission (TNRCC) for the Dallas/Fort Worth (DFW) ozone nonattainment area and Houston-Galveston Area (HGA). The TNRCC rules apply to equipment that is used exclusively for off-road purposes. In order to accelerated the natural turnover rate of such equipment, the rules require that Tier 2 and Tier 3 equipment be purchased at an accelerated rate once available under EPA's mandated schedule. Alternatively, a source may develop a different emission reduction plan that will achieve emission reductions equivalent to the full implementation of accelerated Tier 2 and Tier 3. As part of TNRCC's plan, an owner or operator may achieve reductions, in whole or in part, by participating in an emissions credit banking and trading program.

On October 23, 1998, EPA adopted more stringent emission standards for NO_x, hydrocarbons (HC, which are also called VOC), and particulate matter (PM) for new off-road, compression-ignition engines, to be phased in over several years beginning with model year 1999. This comprehensive new program phases in Tier 2 standards for all engine sizes from model years 2001 to 2006, and more stringent Tier 3 standards for some engine sizes (50hp - 750hp) from model years 2006 to 2008. Under these new standards, the EPA projects that emissions from new off-road, compression-ignition equipment will be further reduced by 60% for NO_x and 40% for PM from the Tier 1 standards adopted in 1994.

The measure affects equipment 50 hp and larger used in the following industry sectors: lawn and garden equipment exhaust (diesel fueled), industrial/commercial equipment exhaust (diesel fueled), agricultural equipment exhaust (diesel fueled), construction exhaust (diesel fueled). Examples of equipment used in these industry sectors include backhoes, bore/drill rigs, cement mixers, crawler tractors, excavators, graders, off-highway trucks, pavers, paving equipment, plate compactors, rollers, rubber-tire dozers, rubber-tire loaders, scrapers, signal boards, skid-steer loaders, trenchers, feller/bunchers, concrete/industrial saws, crushing equipment, oil field equipment, refrigeration/air conditioning units, scrubber/sweepers, rail maintenance equipment, garden tractors, rear engine mowers, chipper/grinders, air compressors, hydro-power units, pressure washers, pumps, generator sets, irrigation sets, welders, aerial lifts, cranes, forklifts, and rough-terrain forklifts.

Effectiveness and Cost of the Measure
It is believed that the total number of off-road diesel equipment in Maricopa County is approximately 32,000 pieces. A 10% participation rate is assumed because of the voluntary nature of the measure, so the program could affect approximately 3,200 pieces of equipment.

The costs of meeting the new federal emission standards are expected to add about 1.0% to the purchase price of typical new off-road, compression-ignition equipment, although for some equipment the standards may cause price increases on the order of 2.0% to 3.0%; however, the cost of TNRCC's program is the cost of having to replace the off-road, compression-ignition fleet on an accelerated schedule, not the cost of Tier 2 and Tier 3 engines. In Texas the program is expected to cost on average $30 million to $42 million per year.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Change in Light Extinction (1/Mm)	0.00	0.30	0.64	0.62	0.56	0.57
Change in Standard Visual Range (Km)	0.0	0.0	0.1	0.1	0.1	0.1
Change in Haziness (Deciview)	0.00	0.019	0.044	0.045	0.041	0.041
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	$0.48	$0.48	$0.16	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	-	-	-	-	-
Levelized Annual Total Cost ($ millions/year)						$0.18
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	$9.69	$4.22	$4.12	$4.45	$4.54

9. Title: Clean Fleet and Equipment Program with State and Local Contract Incentives

Description and Background

This measure encourages owners or operators of heavy-duty diesel equipment and vehicles to either retrofit with NOx reduction systems, particulate filters, replace or convert to LPG or CNG, a minimum 51% of their heavy-duty diesel-fueled fleet equipment (100 horsepower (hp) or greater) which do not meet EPA's standards. The incentive to do so would be the allocation of "extra" points to "clean fleet and equipment" businesses (CFEB) in state contracts. At its November 28, 2000, meeting the Summit agreed to the inclusion of NOx reduction systems, and on-road equipment. In addition, participation by local governments was included to make this control measure consistent with the Off-Road Mobile Control Subcommittee report. The Summit also agreed that new technologies, as they are developed, should be considered for the program. The measure would apply in Area A. The program would be limited to MY 2005 equipment and older.

Diesel equipment represents a significant portion of the total mobile PM_{10} emissions inventory. This includes construction equipment, material handling equipment, agricultural equipment, generators, and haul trucks. EPA finalized emission standards for off-road diesel engines above 50 horsepower in June 1994 (59 FR 31306) and October 1998 (63 FR 56968). Earlier, on October 21, 1997, EPA finalized emission standards for on-road heavy-duty diesel engines, beginning with model year 2004 (62 FR 54694). The normal turnover of diesel equipment results in gradual overall emission reductions, as new equipment is purchased and older pieces are retired.

CARB recently began the process to regulate diesel-fueled engines and vehicles in a comprehensive risk reduction program. Diesel particulate filters are one of numerous control measures CARB identified to reduce diesel PM. Diesel particulate filters have been commercially retrofitted to off-road equipment since 1986. The types of equipment that have been retrofitted include mining equipment, material handling equipment, forklifts, street sweepers, and utility vehicles [Manufacturers of Emission Controls Association (MECA) 2000]. Over 2,500 diesel particulate filter systems are in operation worldwide; some of the systems have been operated for over 15,000 hours or over five years and are still in use. Existing off-road engines that are retrofitted with diesel particulate filters could achieve the similar emission reductions using 50 ppm or lower sulfur fuel as new engines using 500 ppm sulfur fuel.

Examples of NO_x reduction systems are absorbers, methane catalysts, diesel oxidation catalysts, selective catalyst reduction, lean NO_x catalysts, and other exhaust after-treatment systems. Most product information indicates that the proposed technologies for NOx control should be operated on 15 - 50 ppm sulfur diesel for the highest effectiveness.

Under the concept approved by the Summit, a business seeking certification as a CFEB must:

1. Retrofit, replace or convert a minimum of 51% of its heavy-duty diesel-fueled engines and equipment [100 horsepower (hp) or greater] that do not meet EPA's Tier 2 standards for off-road equipment and MY2004 standards for on-road equipment as follows:
    a. retrofit with diesel particulate filters;
    b. retrofit with NOx reduction systems;
    c. replace with or convert to liquified petroleum gas (LPG) or natural gas (CNG) powered vehicles and equipment;
    d. replace or retrofit with new approved technologies;
    e. or any combination of the above;
2. Provide the implementing agency an inventory of heavy-duty diesel vehicles and equipment owned and operated, including:
    a. The purchase date, make, model, model year, horsepower rating, and fuel type for each heavy-duty diesel engine and equipment;
    b. The area in which the affected vehicles and equipment primarily operates;

3. Submit an application affirming under penalty of perjury that the business qualifies as a CFEB and provide any and all materials and information necessary to demonstrate qualification.
4. Certified CFEBs would be listed in the CFEB Directory.

To increase CFEBs' exposure to state and local projects and promote the utilization of certified CFEBs, all state and local agencies would be required to: 1) notify CFEBs in writing of requests for proposal (RFP) and 2) allocate extra "points" (for example, five points) to CFEBs during the bid evaluation process.

Effectiveness and Cost

To calculate emission benefits, ADEQ calculated that the public sector accounts for 29 percent of construction equipment activity in Maricopa County; that State of Arizona contracts account for 60% of this public-sector activity; and that 25 to 50 percent of the eligible companies would participate from 2006 to 2020, with the minimum percentage of equipment converted or retrofitted being 51 percent. Applying these participation rates to the on-road and off-road diesel fleets yields overall fleet retrofit/conversion figures of four to seven percent of the model year 2005 and older portion of the fleet, depending on the year. Given the diminishing size of this older portion of the fleet and the increasing size of the entire fleet from 2006 to 2020, these figures translate into a net conversion of three to five percent of the entire fleet. Net emission reductions are 2.7 to 6.9%, depending on the year, pollutant, and sector (on-road or off-road). At the highest percentage in 2020 for off-road diesel controls, the emission reduction is 163 metric tons per year of fine particulate.

Particulate filters may be operated on the existing diesel fuel found in Area A, though they are more effective when operated on ultra low sulfur fuel (50 ppm or less). CARB diesel fuel (approximately 150 ppm) is estimated to cost 6½ cents/gallon more than the present Area A fuel. The incremental cost between Area A diesel fuel and 15 ppm sulfur diesel fuel is 10 cents/gallon; 50 ppm is 5 cents/gallon. At an average annual maintenance cost of $500, the average operating and maintenance costs per piece of equipment are about $1200 per year. The cost of retrofitting was calculated at $11,750 per piece of equipment. These costs have been used to calculate the cost/benefit ratios in the visibility assessment tool.

The cost of NOx emission control devices would range from $500 to $2,000 per heavy-duty off-road vehicle/equipment. This cost is based on a report from the Manufacturers of Emission Controls Association titled *Emission Control Retrofit of Diesel-Fueled Vehicles*. For assessment purposes, the Area A off-road vehicle/equipment population was estimated at 20,815 in 1992; 24,736 in 1995; 30,336 in 2003; 32,353 in 2006; 35,070 in 2010; 38,570 in 2015; and 42,267 in 2020. Comparable figures for the on-road heavy-duty diesel vehicle population, based on the January 2, 2000 population and on population-based growth factors, are 22,367 in 2000, 29,255 in 2006, 31,711 in 2010, 34,876 in 2015, and 38,219 in 2010.

The feasibility and cost associated with converting off-road heavy-duty diesel vehicles/equipment to liquified petroleum gas (LPG) or natural gas (CNG) and replacing off-road diesel vehicles/equipment with commercially available LPG or CNG equipment/vehicle is unknown at this time. Therefore, these costs have been left out of the analysis for the present time.

Although conversion programs for on-road heavy-duty diesel vehicles have been successful (see, for example *North American Edition Diesel Progress* (October 2000, pp 40-42)), published cost information is scanty. As with the off-road sector, these costs have been left out of the present analysis.

The incremental cost of using 15 ppm sulfur diesel fuel with the new devices would be approximately 10 cents/gallon over the price paid today in Maricopa County for diesel fuel. The incremental cost of using 50 ppm sulfur diesel fuel would be approximately 5 cents/gallon.

There would be administrative costs associated with the CFEB program, including costs for rule development, equipment certification, program management, and enforcement.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.00	0.63	0.88	0.91	0.91
Change in Standard Visual Range (Km)	0.00	0.00	0.10	0.20	0.20	0.20
Haziness (Deciview Improvement)	0.00	0.00	0.043	0.064	0.067	0.065
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	-	$0.02	$0.04	$0.06	$0.08
Levelized Annual Total Cost ($ millions/year)						$0.05
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	N/A	$1.26	$0.84	$0.80	$0.83

10. Title: Voluntary Replacement of Airport Ground Support Equipment (GSE)

Description and Background

This measure encourages the replacement of internal combustion engine-powered airport ground support equipment (GSE) with low- or zero-emission GSE at airports. At its October 24, 2000, meeting the Subcommittee agreed to look at two variations of the program for the Phoenix area A - a goal of 7.5% electric vehicles by 2005 for all airports and a goal of 30% by 2005 for Sky Harbor Airport. At the December 5, 2000, Brown Cloud Summit meeting the Summit voted to recommend the 30% voluntary replacement of GSE by 2005 for Sky Harbor Airport.

Airport GSE is used from the moment an aircraft lands until the aircraft takes off for a new flight. Airport GSE is comprised of a variety of vehicles and equipment necessary to service aircraft during ground-based operations, including cargo loading and unloading, passenger loading and unloading, potable water storage, lavatory waste tank drainage, aircraft refueling, engine and fuselage examination and maintenance, and food and beverage catering. Airport GSE includes, but is not limited to, aircraft pushback tugs, baggage and cargo tugs, carts, forklifts, lifts, ground power units, air conditioning units, air start units, and belt loaders. Registration or permitting is currently not required for GSE and there is not a national organization charged with tracking GSE activity. Consequently, the databases used to estimate GSE activity are not very reliable. Best estimates based on national and TNRCC information were used for input into the tool. GSE that has already been converted was not included in this estimate because of the lack of such data.

Effectiveness and Cost

The majority of GSE engines are “uncontrolled” from an emission perspective, because they have not been designed for low emissions. Therefore, GSE emits significant amounts of VOC and NOx. An EPA report (420-R-99-007) states that GSE is responsible for 15% - 20% of airport- related NOx and 10% - 15% of airport-related VOC emissions.

TNRCC reports the initial purchase cost of electric-powered GSE is typically higher than diesel-powered and gasoline-powered GSE. A recent report by the EPA, Technical Support for Development of Airport Ground Support Equipment Emission Reductions (EPA 420-R-99-007, May 1999), estimated that the cost of an electric baggage tractor would be $30,000, while the gasoline-powered version would be $17,000, and the diesel-powered version would be $22,000. However, electricity is such a less expensive power source than fossil fuels, that the savings in the cost of fuel will offset the increased electric GSE purchase price in two to three years.

Visibility Assessment Tool Results (Worst 20% Average Winter Day) 30% Conversion of GSE to Electric at Sky Harbor Airport by 2005

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.34	0.61	0.48	0.45	0.46
Change in Standard Visual Range (Km)	0.00	0.10	0.10	0.10	0.10	0.10
Haziness (Deciview Improvement)	0.00	0.022	0.042	0.035	0.033	0.033
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	$1.62	$1.08	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	$ -0.03*	$-0.06	$-0.06	$-0.06	$-0.06
Levelized Annual Total Cost ($ millions/year)						$0.39
Cost Benefit (Levelized Annual Cost per Deciview Change) ($ millions/deciview)	n/a	$17.80	$9.27	$11.15	$11.86	$11.76

*(-) sign indicates annual cost savings, in this case due to reduced operating and maintenance expenses for electric vehicles.

11. Title: Ban Leaf Blowers

Description and Background

This measure would ban the use of all leaf blowers in Area A. Leaf blowers resuspend particulate matter into the air and also generate VOCs and CO emissions. A ban on all leaf blowers would reduce emissions of these pollutants from both combustion emission reductions and fugitive emission reductions. The Legislature would enact this measure into law. If legislation was enacted in 2001, the program could take effect in 2002 or 2003. This measure would affect the lawn and garden equipment sector.

Effectiveness and Cost

In 1997 Sierra Research estimated that this measure would reduce PM_{10} emissions by 3.74 metric tons per day (0.008 tons per day per unit). Recent estimates utilizing emission factors developed by CARB ("A Report to the California Legislature on the Potential Health and Environmental Impacts of Leaf Blowers", California Air Resources Board, February 29, 2000), found the measure would result in the following reductions:

Combustion of fuel (in tons per day)

- hydrocarbons - 1.31
- CO - 3.83
- NO_X - 0.004
- PM_{10} - 0.0006
- $PM_{2.5}$ - 0.0115

Fugitive particulate emissions (in tons per day)

- PM_{10} - 4.6
- $PM_{2.5}$ - 2.18

Assumptions made in the estimate include:

- 95% of combustion particulate is $PM_{2.5}$ or less.
- Electric blowers make up 5% of commercial blower population.
- Estimate of 50,000 blowers in 2000 based upon growth of 1992 inventory of non-road equipment to a Maricopa County population of 3.1 million.
- Estimated that 6% of blowers are in operation on any day with an average operation of 2 hours.
- Equipment population data source: "1992 nonroad emission inventories for CO and ozone nonattainment boundaries Phoenix, Arizona (EPA 1992)".
- Resuspended emission factors based upon average Riverside, California, silt loading.

The Sierra research estimated cost effectiveness of $216 per metric ton was utilized in the recent analysis. City of Mesa estimated that substitute methods to the use of leaf blowers may increase commercial landscape contract costs by 15 to 30 percent. Lawn maintenance firms would require additional manpower to replace the blowers because debris sweeping and raking are more time intensive than blowing debris. This could increase the cost of lawn maintenance to the consumer; however, if the ban was enforced regionally in Area A, market conditions would likely limit cost increases. Because of the large number of units currently in use, enforcement may be difficult.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Fuel Combustion and Fugitive Dust Emissions

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	2.26	2.26	2.26	2.26	2.26
Standard Visual Range Improvement (Km)	0.00	0.4	0.4	0.5	0.5	0.5
Haziness Improvement (Deciview)	0.00	0.145	0.156	0.165	0.167	0.162
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	0.00	0.36	0.36	0.36	0.36	0.36
Levelized Annual Total Cost ($ millions/year)						0.36
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	2.50	2.33	2.20	2.18	2.24

12. Title: Additional Funding for PM_{10} Efficient Street Sweepers

Description and Background

This measure would provide additional funding to purchase PM_{10} efficient street sweepers to reduce particulate emissions from paved roads in Area A. This would be in addition to the Congestion Mitigation Air Quality (CMAQ) funds currently allocated by the Maricopa Association of Governments (MAG). The FY 2001-2005 MAG Transportation Improvement Program (TIP) contains CMAQ funding to purchase PM_{10} certified street sweepers. The funding levels are $960,000 per year in 2001 through 2004 and $1.92 million in 2005. A minimum local match of 5.7% is required. It is estimated that approximately 48 sweepers can be purchased with available funds. The objective of this measure is to accelerate the number of PM_{10} efficient units used to sweep roads with heavy silt loadings. An adequate source of funding for the additional PM_{10} efficient street sweepers would need to be obtained for this measure. The implementation period is dependent on the availability of funding.

Effectiveness and Cost

MAG estimated that each PM_{10} efficient street sweeper would provide a reduction of 334 kilograms per day (0.368 tons per day) of PM_{10}. Assuming the addition of 40 PM_{10} efficient street sweepers by 2006, the total daily reduction of PM_{10} would be 14.72 ton per day of PM_{10} and 2.9 tons per day of $PM_{2.5}$ (assuming that $PM_{2.5}$ emissions are 20% of the total PM_{10} emissions).

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.73	0.73	0.73	0.73	0.73
Standard Visual Range Improvement (Km)	0.00	0.1	0.1	0.2	0.2	0.1
Haziness Improvement (Deciview)	0.00	0.047	0.050	0.053	0.054	0.052
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	6.00	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	-	-	-	-	-
Levelized Annual Total Cost ($ millions/year)						0.99
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	21.24	19.77	18.64	18.46	19.00

13. Title: Replace Generators with Electric Power at Construction Sites

Description and Background

This measure would mandate that utility-supplied electrical power be provided at residential construction sites in Area A in lieu of portable generators. In 1998, the measure was proposed as a voluntary program until January 1, 2000, at which time the Executive Branch was to decide whether the program should continue to be voluntary or whether it should be transition to a mandatory program. This measures would make the program mandatory by action of the State Legislature.

Arizona Public Service (APS) and Salt River Project (SRP) originally committed to providing this service to 15% of new homes constructed each year. From January 1998 through October 1998, SRP averaged 40 installations of these devices per month. These devices are typically installed for three months. It was projected there were 500 installations in 1998. If this measure were mandatory, homebuilders would need additional lead-time for providing electrical power before other scheduled construction activities. Utilities would need to have capacity to meet these additional requirements. It is anticipated that some areas will not have the utility infrastructure, delaying building activities. It is assumed that 80% of new homes would be able to replace fuel-fired generators. The main barrier is the ability of utility companies to provide service to new construction areas in a timely manner.

Effectiveness and Cost

The cost effectiveness for each affected pollutant, as estimated by in the 1998 Task Force Report, is listed below:

Pollutant	Estimated Annual Reduction (tons/year)	Cost Effectiveness ($/tons reduced)
CO	1,292	$348
VOC	29.3	$15,360
PM_{10}	1.2	$374,000

The emission reduction estimates are based on the net difference between emissions from fuel-fired portable generators and emissions resulting from generation of an equivalent amount of electricity by utility power plants. Relative costs for temporary electrical power connections and on-site generation may differ depending on the location and size of the site. The Home Builders Association of Central Arizona provided information that estimated approximately 30,000 new home starts per year for 1999-2005 in Maricopa County.

Arizona utility companies estimate the cost of installation and electricity usage to be less than $100 per home. Assuming the average number of homes built in the Phoenix area per year is 30,000, and an estimated 80% compliance rate which results in 24,000 homes per year, the cost of the program is $2.4 million per year. Direct costs would be borne by homebuilders.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.16	0.91	0.71	0.66	0.67
Standard Visual Range Improvement (Km)	0.00	0.00	0.2	0.1	0.1	0.1
Haziness Improvement (Deciview)	0.00	0.01	0.063	0.052	0.049	0.048
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	2.40	2.40	2.40	2.40	2.40
Levelized Annual Total Cost ($ millions/year)						2.40
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	234.94	38.19	46.16	49.28	49.95

14. Title **Increase Funding for Maricopa and Pinal Counties Inspection and Dust Control Program**

Description and Background

This measure adds five additional full time personnel for the enforcement of fugitive construction dust; four personnel for Maricopa County, one for Pinal County. Maricopa County's program currently has 8 inspectors, a supervisor, a coordinator, 2 enforcement officers, a county attorney and support staff. The inspectors are responsible for the entire county, with the majority of the construction sites located inside the PM_{10} nonattainment area. Maricopa County Environmental Services Department may need to obtain legislative authority to increase it's expenditure budget before the additional staff could be hired.

Effectiveness and Cost

Each 5% improvement in the compliance rate results in an estimated additional reduction of 4.7 metric tons per day of PM_{10} (1.7 metric tons of $PM_{2.5}$) or approximately 1500 metric tons per year of PM_{10} (540 tons of $PM_{2.5}$) assuming 313 days per year for construction activities. These estimates were derived by increasing the compliance rate by 6.5% and recalculating the 2006 emissions reductions using the methodology on page V-10 of the "Technical Support Document" for the "Revised MAG 1999 Serious Area Particulate Plan for PM_{10} for the Maricopa County Nonattainment Area." Each additional inspector can make approximately 750 inspections per year averaging simple and complex inspections. The cost per inspector including all direct and indirect costs (vehicles, space, support staff, supervision, etc.) is approximately $105,000. It is estimated that it would take five (5) additional staff to achieve a 6.5% improvement in compliance. This would equal $525,000 for 5 new FTE's.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.48	0.37	0.43	0.48	0.51
Standard Visual Range Improvement (Km)	0.00	0.1	0.1	0.1	0.1	0.1
Haziness Improvement (Deciview)	0.00	0.031	0.025	0.032	0.035	0.037
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.53	0.57	0.65	0.75	0.86
Levelized Annual Total Cost ($ millions/year)						0.69
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	22.51	26.98	21.76	19.69	18.76

15. Title: Dust Control Training For Contractors; Develop and implement a standardized dust control certification training program for construction activities for compliance with Maricopa County Rule 310

Description and Background

This measure would establish a standardized dust control certification training program for construction companies and other stakeholders in Maricopa County to enhance compliance with Maricopa County Rule 310. Participation in the training and certification would be required for a construction company to obtain a county permit. This program utilizes Arizona Department of Transportation's (ADOT's) interim training class, the particulate matter (PM_{10}) manual already developed and the $150,000 obtained from the Federal Highway Administration by ADOT Transportation Planning Air Quality Team to continue the educational and outreach effort for public and private stakeholders. The standardized training certification program should be available in late 2001 or early 2002. The scope of work is currently being developed. A Technical Advisory Committee (TAC) would be established to complete the scope of work, work with a consultant to develop the standardized training program and assist in developing the implementation plan. The TAC would include representatives from ADOT, Maricopa County Environmental Services Division, Arizona Department of Environmental Quality, the contractor community, and regional city representatives. The project manager for the development of the education program will be an environmental representative from the Arizona Transportation Research Center.

Effectiveness and Cost

There is no analytical method to estimate of the effectiveness of training on the reduction of visibility pollutants. The input to the visibility assessment tool assumed that education and dust control certification would reduce particulate matter generation by 5%. This is similar to the factor used for increased dust control inspections. The cost for the class would be a nominal registration fee for each participant. Stakeholders would be responsible for coordinating implementation of the training program within their own organizations. The training program could be integrated into appropriate agencies' current training programs and also be included in the curriculum of a Community College. Maricopa County Environmental Services Department would manage and report on the effectiveness of the training program.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.08	0.08	0.11	0.15	0.18
Standard Visual Range Improvement (Km)	0.00	0.00	0.00	0.00	0.00	0.00
Haziness Improvement (Deciview)	0.00	0.005	0.005	0.008	0.011	0.013
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.15	-	-	-	-
Levelized Annual Total Cost ($ millions/year)						0.02
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	4.34	4.18	2.75	2.11	1.79

16. Title: Expansion of Area A

Description and Background

This measure would add high growth communities in the West Valley, including Buckeye and Surprise, to Area A, which is currently defined at A.R.S. § 49-541. These communities were included in the proposed expansion in SB 1427 at the beginning of the 1998 legislative process, but were later excluded as the law was finalized. Area A is the boundary for the applicability of several air pollution control programs including fireplace burning restrictions on wintertime pollution alert days, requirements for clean burning fireplaces in new construction, vehicle emission testing, Stage II vapor recovery, stabilization of roads, alleys, and shoulders, vacuum systems for crack and seal operations, vehicle fleet plans and trip reduction programs, parking prohibitions for municipal employees not participating in the VEI program, traffic light synchronization, alternative fuel vehicle requirements for local governments and school districts, on-road diesel fuel for off-road engines, and retirement of pre-1988 heavy duty diesel engines before 2004.

Effectiveness and Cost

The tables under the "Visibility Assessment Tool Results" section describe the potential visibility benefits associated with an expansion of Area A to the west. The estimate includes fireplace burning restrictions on wintertime pollution alert days, requirement for clean burning fireplaces in new construction, and vehicle emission testing for the potential expanded portion of Area A. Expanding the boundaries of Area A will subject the individuals and entities in the affected areas to costs associated with new regulatory requirements.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Emission Testing and Wood Burning Control Measures

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.01	0.01	0.01	0.01	0.01
Standard Visual Range Improvement (Km)	0.0	0.0	0.0	0.0	0.0	0.0
Haziness Improvement (Deciview)	0.00	0.0009	0.0008	0.0007	0.0006	0.0006
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	0.40	0.40	0.40	0.40	0.40
Annual Operating and Maint. Cost ($ millions/year)	-	0.87	0.87	0.87	0.87	0.87
Levelized Annual Total Cost ($ millions/year)						1.20
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	1357.09	1449.73	1666.43	1960.61	2120.26

17. Title: Air Quality Alert Days

Description and Background

This measure adds visibility-related pollutants to the current air quality alert system. The proposed alert criteria is PM_{10} >100 Fg/m^3 (microgram per cubic meter). The winter time air quality alert program monitors carbon monoxide and particulate matter (PM_{10}). The summer-time air quality alert system monitors ozone. This program would standardize the action plans for all air quality alert days.

In 1999, Maricopa County called six winter-time air quality alert days for exceeding >120 µg/m^3 of PM_{10} particulate. This proposal would reduce the index to >100 µg/m^3 PM_{10} particulate. It is estimated that with this index value there would be approximately twelve PM_{10} air quality alert days called per winter season. Public response is most effective when there are a reasonable number of alert days called.

Effectiveness and Cost

The measure is estimated to reduce 2.3 million vehicle miles traveled per alert day in the Phoenix metropolitan area, which is a 3.5% reduction. Estimates are based upon a 1999 survey aimed at assessing the success of the Ozone Alert Program conducted by West Group Research under contract with the Regional Public Transportation Authority. The 3.5% reduction rate was also used for reduction in residential wood burning for input into the visibility assessment tool.

Cost for this measure is based on one full time equivalent personnel for administrative support of the program. Covered in this estimate is manpower for air quality monitor maintenance, data reduction and quality assurance, data transmittal, and coordination with facilities and the media. Operational costs are estimated to increase 3% annually.

Visibility Assessment Tool Results (Worst 20% Average Winter Day)
Wood Burning Restrictions and Gasoline Vehicle Exhaust

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	0.07	0.04	0.03	0.03	0.03
Standard Visual Range Improvement (Km)	0.00	0.00	0.00	0.00	0.00	0.00
Haziness Improvement (Deciview)	0.0000	0.0045	0.0030	0.0024	0.0019	0.0018
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	0.11	0.11	0.13	0.15	0.17
Levelized Annual Total Cost ($ millions/year)						0.14
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	n/a	30.76	46.13	56.54	71.30	74.45

18. Title: Mandatory Adoption of CARB Diesel (On-road and Off-road)

Description and Background

This measure would require that all diesel fuel sold in Area A conform to the specifications of CARB diesel. Both on- and off- road diesel engines are significant contributors of CO, VOC, NOx, primary particulate matter, PM precursors and hazardous air pollutant (HAP) emissions. Emissions of all of these pollutants can be reduced with the use of reformulated diesel fuel.

As recommended by the Governor's Air Quality Task Force in 1998 (Task Force), this control measure would require that all diesel fuel sold for use in Area A, whether for on-road or non-road uses, conform to the specifications set under the CARB diesel fuel program (including either the formula properties or alternative formulations). This control measure is on the potential list of the most stringent PM control measures implemented or in-practice in any PM nonattainment area (Sierra Research/Maricopa Association of Governments 1998). CARB diesel was one of the recommended control measures contained in the 1999 MAG Brown Cloud Study.

The Legislature would need to revise ARS Title 41, Chapter 15, Article 6 to set the basis for the standards and authorize the Arizona Department of Weights and Measures (ADWM), in consultation with ADEQ, to adopt necessary rules to implement these standards. Further, ADEQ would be required to submit the program to EPA as a revision to the PM_{10}SIP, and obtain necessary waivers under §211(c)(4) of the Clean Air Act. The program would become effective upon EPA's approval and granting of the waiver from federal preemption provisions that prevent states from setting standards for motor fuels under certain circumstances. Once rules were adopted and approved, ADWM would enforce them under the existing motor fuel quality regulatory program.

Effectiveness and Cost

Based on the inventories used by MathPro, this control measure will reduce $PM_{2.5}$ by 115 to 125 tons per year (including secondary nitrate and sulfate) and NOx by 996 to 1,296 tons per year, from on-road diesel vehicles and 340 to 354 tons per year (including secondary nitrate and sulfate) and NOx by 225 to 293 tons per year (wintertime) and 895 to 1,116 tons per year (summertime), from off-road diesel vehicles. In addition, it would provide substantial reductions in VOC and CO.

The total incremental refinery cost was estimated by MathPro to be 4 to 10¢ / gal, depending upon the mix of fuels meeting either formula or average CARB diesel properties (MathPro, 1998). Similarly, the estimated loss of fuel mileage performance due to the use of this diesel fuel formulation may range from 1.1 to 2.4 ¢/gal. Thus, the total incremental cost including the fuel economy penalty is between 5.1 and 12.4 ¢/gal.

On the whole, petroleum industry representatives indicate that a consumer fuel price increase is probable with mandated CARB diesel. Wholesale price differences between federal low-sulfur diesel fuel and CARB diesel have averaged about 6.5 ¢/gal. since 1997, and the price differential at the retail level appears to be very similar. (See memorandum from Ira Domsky to Edward Z. Fox, September 6, 2000.) This is the incremental cost difference, plus the mileage penalty, has been used for evaluating this control measure.

Such an increase would affect different segments of the market to varying degrees. To the extent long-haul trucks have the ability to avoid higher priced CARB diesel in Maricopa County, this segment may not bear a significant fuel cost increase. Thus the overall cost impact of this measure, and its effect on diesel retailers in Maricopa County, depends in part on the degree to which a fueling pattern shift occurs. An analysis of diesel registration and traffic data resulted in an assessment that locally purchased (CARB) diesel fuel would be used for 28% of the diesel vehicle miles traveled (See memorandum from Ira Domsky to On-Road Mobile Sources Subcommittee, November 2, 2000). Comments received identified potential problems with the analysis, primarily that the total diesel vehicle miles traveled (VMT) did not conform with Maricopa

Association of Governments figures. While reevaluating the potential impact of this problem with the analysis, it was also discovered that local diesel VMT were derived from year 2000 registration data, whereas the VMT figures were for 1998. The following table provides a comparison of the outcomes of both the original and revised analyses, with respect to proportion of total diesel VMT represented by diesel vehicles using locally purchased fuel, and the cost of CARB diesel. This analysis only affects the costs and benefits relative to on-road use of CARB diesel.

	Original Analysis	**Revised Analysis**	**Comment**
Daily Diesel VMT in 1998	8,309,000	4,400,000	Revised analysis uses MAG VMT estimate
Locally Registered Diesels	25,245	22,400	Original analysis used 2000 registration data; Revised is based on an estimate of heavy-duty diesel vehicles tested in Maricopa County by Gordon Darby in 1998 of 20,900, plus 1,500 for fleet inspection certificates used.
Local Diesel VMT	1,662,600	1,475,200	Revised analysis prorated from original analysis, based on estimate of registered vehicles
Percent of total diesel VMT	20.0%	33.5%	
Non-local Diesel VMT	6,646,400	2,924,800	
Non-local diesel miles using local fuel (10%)	664,640	292,480	
Percent of total diesel VMT	8.0%	6.7%	
Percent of total diesel VMT driven using local fuel	28.0%	40.2%	
Local vehicle fuel demand (bbl/day)	5,671	5,032	Based on vehicle class mix from registration data, from Oak Ridge Transportation Energy Book (9/99)
Non-local vehicle fuel demand (bbl/day)	2,261	995	Assumed 7 miles/gallon, *ibid.*
1998 Total local diesel fuel demand (bbl/day)	7,932	6,027	
Incremental Cost of CARB diesel, (¢/gallon)	6.5	6.5	
Total Cost, including mileage penalty ($/year)	$7,990,784	$6,071,666	Original based on estimated 2000 vehicle population; revised based on estimated 1998 population.
2003 Total Cost ($/year)	$8,833,811	$7,176,709	Original analysis growth factor - 3 yrs, 10.55%; revised - 5 yrs, 18.2%; annual for both 3.4%.

The revised analysis increases the overall benefit of this control measure and the on-road portion of the Voluntary Early Implementation of Ultra-Low Sulfur Diesel for use in On- and Off-Road Diesels Retrofitted with Oxidation Catalysts and Particulate Filters measure, because these two measures impact the same portion of the diesel fleet. Revised estimates of visibility benefit and cost-effectiveness appear below.

For off-road diesel equipment (e.g., construction equipment, portable generators and compressors), it was assumed that 85% of the diesel fuel used would meet CARB standards.

It is assumed that short-haul local trucks would almost totally be converted to higher priced CARB diesel. Many of these vehicles are in centrally fueled fleets. Regardless, an incentive exists to refuel outside of the area. If one assumes that the current average wholesale price difference between CARB and EPA diesel fuel would be reflected in retail prices, a 100 gallon refuel with EPA diesel would provide a savings in the cost of the fuel of $6.50.

This is a relatively cost-ineffective measure for reducing PM from vehicles and off-road equipment - from over $36,000 to $87,000 per ton. When all pollutants are considered, the cost effectiveness of this measure for on-road vehicles is $3,000 to $5,000 per ton (MathPro, 1998).

Visibility Assessment Tool Results (Worst 20% Average Winter Day)

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	2.60	2.73	1.92	1.83	1.87
Change in Standard Visual Range (Km)	0.0	0.4	0.5	0.4	0.4	0.4
Haziness (Deciview Improvement)	0.00	0.167	0.188	0.140	0.135	0.134
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	18.41	19.38	21.83	24.72	27.62
Levelized Annual Total Cost ($ Millions/year)						22.89
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	$136.96	$121.49	$163.15	$169.41	$170.82

19. Title: Voluntary Early Implementation of Ultra-Low Sulfur Diesel for Use in On- and Off-Road Diesels Retrofitted with Oxidation Catalysts and Particulate Filters

Description and Background

This measure would encourage the early implementation of ultra-low sulfur diesel (ULSD) for use in on-road diesel vehicles and off-road diesel equipment retrofitted with oxidation catalysts and particulate filters, and could be implemented in the 2001 to 2003 time period. In response to Western States Petroleum Association's (WSPA's) request, MathPro Inc., together with Energy and Environmental Analysis, Inc. (EEA), conducted a quick-response analysis of WSPA's proposed voluntary ULSD program for Maricopa County. The following summarizes the methodology and findings of their analysis.

For purposes of this analysis, the assumptions are:

- The term "ULSD" denotes a sulfur standard of either 50 ppm (cap) or 15 ppm (cap). *This analysis covers both.*
- The term "after-treatment technology" denotes passive continuously-regenerating particulate filters (with integrated oxidation catalysts).
- The term "vehicles" denotes both new vehicles equipped with such after-treatment technology and older vehicles retrofitted with this technology.
- The proposed ultra-low sulfur diesel would be supplied to Area A as soon as practical, but not later than January 1, 2003.
- The WSPA program would terminate on the in mid-2006, the effective date of the federal Tier 2 diesel sulfur program.

Effectiveness and Cost

Table 7.1. shows the estimated combined emission reduction impacts of ULSD fuel properties and diesel particulate filter technology for a *single affected vehicle*. As indicated, HC and CO reductions of well over 90% are expected with either ULSD fuel formulation. Expected NO_x reductions are modest in general, but twice as great for the 15 ppm ULSD. With either ULSD, expected particulate reductions are significant, but given current technology (i.e., worst case impacts for 50 ppm ULSD), PM reductions of over 90% would be achievable only with 15 ppm ULSD. Nevertheless, reductions with 50 ppm ULSD sulfur fuel are significant: more than 70%.

Table7.2 shows estimated emission impacts for the entire Maricopa County on-road heavy duty diesel vehicle fleet. In effect, Table 7.2 reflects (1) the estimated per-vehicle emission reductions shown in Table 7.1 and (2) the fleet penetration estimates.

Depending on the particular fleet targeted, overall heavy duty diesel vehicle emission reductions as shown in Table 7.2 range from 11% to 52% for PM, 15% to 54% for HC, 14% to 52% for CO, and 1% to 7% for NO_x. The significance of these estimated emissions reductions is evident when one considers the estimated emissions reductions for CARB diesel indicated in the October 5, 2000 ADEQ memo previously cited – 6% to 9% for PM, 29% to 36% for HC, 18% to 29% for CO, and 4% to 6% for NO_x.

Even though the emissions benefits of CARB diesel would apply to both on- and off-road diesel engines, it is clear that emissions reductions from ULSD with a targeted retrofit program for fleet vehicles could approach or exceed those of a countywide fuel program, depending on the extent of the fleet vehicles targeted for control. Although no specific analysis of off-road vehicle fleet populations was originally undertaken for this analysis, availability of particulate filters and oxydation catalysts suitable for off-road engines, and, to a lesser extent, fuel supply and logistics, could limit the full potential of this fleet program to the off-road sector. This control measure applies to both on- and off-road vehicles, under the assumption that these technical limitations are either limited or nonexistant.

Table 7.1.: Estimated Combined Fuel and Filter Vehicle-Specific Emission Impacts

Pollutant	15 ppmW Sulfur	50 ppmW Sulfur Best Case	50 ppmW Sulfur Worst Case
HC	-98.4%	-97.9%	-97.9%
CO	-95.2%	-94.3%	-94.3%
NO_x	-12.2%	-6.5%	-6.5%
PM	-93.9%	-93.2%	-70.9%

Table 7.2.: Estimated Combined Fuel and Filter On-Road Fleet-Specific Emission Impacts

	15 ppmW Sulfur Fuel			50 ppmW Sulfur Fuel			50 ppmW Sulfur Fuel		
	Targeted Centrally Fueled Fleets			Targeted Centrally Fueled Fleets			Targeted Centrally Fueled Fleets		
	All	Public	Public + Utility	All	Public	Public + Utility	All	Public	Public+ Utility
				Best Case Scenario			Worst Case Scenario		
HC	-54.2%	-15.0%	-34.0%	-53.9%	-14.9%	-33.8%	-53.9%	-14.9%	-33.8%
CO	-52.4%	-14.5%	-32.9%	-51.9%	-14.4%	-32.5%	-51.9%	-14.4%	-32.5%
NO_x	-6.7%	-1.9%	-4.2%	-3.6%	-1.0%	-2.2%	-3.6%	-1.0%	-2.2%
PM	-51.7%	-14.3%	-32.4%	-51.3%	-14.2%	-32.2%	-39.0%	-10.8%	24.5%

Given the lack of practical experience with such filter systems and the fact that purchase costs are based on current low volume production, these estimates should be viewed as upper limits. Costs are likely to decrease as demand increases. Recognize that up-front costs – purchase and installation – account for 75% to 80% of total costs (for purchase costs in the $6,000 to $8,000 per vehicle range, for on-road applications).

Additional costs included in the tabulated estimates consist of periodic trap cleaning to remove accumulated ash and metals, periodic maintenance to inspect and adjust filter systems, and (under worst case conditions) a small fuel consumption penalty. Data currently being collected suggest that this latter cost is likely to be zero in the long run, which is reflected in the **Best Estimate** in Table 7.3.

Table 7.3.: Estimated Total Incremental Costs for On-Road Applications: Operating Costs plus ULSD Costs

ULSD	50 ppm			15 ppm		
	Lower Estimate	**Upper Estimate**	**Best Estimate**	**Lower Estimate**	**Upper Estimate**	**Best Estimate**
Incremental Cost (¢/mile)	**2**	**3**	**2**	**3**	**4**	**3**
-- Fuel Cost	1	1	1	2	2	2
-- Operating Cost	1	2	1	1	2	1
Incremental Cost (¢/gal)	**9**	**22**	**11**	**14**	**27**	**16**
-- Fuel Cost	5	5	5	10	10	10
-- Operating Cost	4	17	6	4	17	6

This control measure has been modeled assuming that the local fleets are responsible for 40.2% of the vehicle miles traveled, consistent with what was estimated for the evaluation of Mandatory Adoption of CARB Diesel. Even though the cost of 15 ppm sulfur fuel is higher, under an emissions trading program, a fleet manager may find the additional emissions reductions that come with use of the higher cost fuel advantageous. Based on comments received regarding investments already made by many public fleets to convert to alternative fuels and the potential to use reductions from fleets as offsets that could be sold to new existing industrial sources, the best-case scenario does not assume 100% participation of public and utility fleets in this program. Further, with the promulgation of the federal Tier 2 diesel standards rule, it is also assumed that 50 percent of the fleet converted under this program will be depreciated and replaced with new Tier 2 vehicles by 2020.

The effectiveness and costs for off-road component of this measure have been modeled with the use of 50 ppm and 15 ppm fuel sulfur content at a low-sulfur fuel volume of 1,548 bbl/day. Under an emissions trading scenario, a fleet owner may find it advantageous to buy new or retrofit existing vehicles with aftertreatment technology and use lower sulfur fuel despite the higher costs.

MathPro evaluated a range of scenarios involving different fuel sulfur levels and different penetration rates. The assumed ULSD fuel demand under the off-road program would be 1,548 bbl/day, or about 23.7 million gallons per year. Based on an estimated total off-road fuel demand of 173 million gallons per year, ULSD would supply 13.7% of this demand. The 13.7% penetration factor was used to estimate the emission reductions. The emission reductions can be adjusted if needed to reflect different volumes of ULSD and/or Area A off-road demand.

MathPro did not supply any information about the population of off-road vehicles. The costs and emission reductions could apply to any mix of public, utility and private off-road fleet vehicles, but, because of the logistics associated with a special-order fuel, would be restricted to portions of the off-road fleet that are served by dedicated refueling facilities. Even though ULSD will be readily available after mid-2006, no mandate exists to require the use of this fuel in off-road diesel equipment. As a result, the same assumption carries into future years, with replacement of retired retrofitted equipment with like equipment.

PM emission reductions for the 50 ppm option were modeled using the average of the 50 ppm best and 50 ppm worst cases. Other emissions reduction estimates are the same as provided by MathPro and EEA.

This control measure also provides substantial reductions, on a per-retrofitted unit basis, of SOx, NOx, VOC and CO.

The cost estimates provided are consistent with the emission reduction estimates - both assume use of 1,548 bbl/day. Although there will be capital costs incurred to purchase particulate filters, MathPro did not supply capital costs separately. The capital costs are included in the operating cost figure that is provided (MathPro converted capital costs into a cents per gallon equivalent).

To be consistent with the way that other off-road retrofit control measures were evaluated, ADEQ applied an average cost of $11,750 per retrofit, calculated from Table 7.4, which also appears in the Off-Road Mobile Controls Subcommittee report on page 27:

Table 7.4: Off-Road Engines: Current Cost for Retrofit

Horsepower	***190***	***250***	***475***
Diesel Particulate Filter	$5,700 - 9,500	$8,250 - $13,750	$13,500 - 23,750

Costs were estimated on a per-gallon basis using the same approach as MathPro, in Table 7.5:

Table 7.5: Estimated Total Incremental Operating and Fuels Costs for Off-Road Applications

Average Filter Purchase Cost	$11,750
Gallons of fuel	136,364
Total up-front costs	8.6 ¢/gal
Maintenance costs	0 ¢/gal
Incremental cost for 50 ppm fuel	5 ¢/gal
Incremental cost for 15 ppm fuel	10 ¢/gal

Tables 7.6 and 7.7 provide the results of the Brown Cloud Evaluation Tool for "worst" and "best" case scenarios if this control program is implemented.

Table 7.6: Visibility Assessment Tool Results (Worst 20% Average Winter Day): 50 ppm sulfur, 50% penetration of eligible on-road fleets, 13.7% penetration of off-road equipment fleet - worst case

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	2.14	2.24	1.68	1.58	1.59
Change in Standard Visual Range (Km)	0.0	0.3	0.4	0.4	0.3	0.3
Haziness (Deciview Improvement)	0.00	0.137	0.154	0.123	0.116	0.114
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	4.54	4.54	-	-	-
Levelized Annual Total Cost ($ millions/year)						1.59
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	$11.58	$10.29	$12.93	$13.64	$13.89

Table 7.7: Visibility Assessment Tool Results (Worst 20% Average Winter Day): 15 ppm sulfur, 75% penetration of eligible on-road fleets, 13.7% penetration of off-road equipment fleet -best case

Visibility Changes - Baseline vs. Control Option	1995	2003	2006	2010	2015	2020
Light Extinction Improvement (1/Mm)	0.00	2.61	2.71	2.03	1.88	1.88
Change in Standard Visual Range (Km)	0.0	0.4	0.5	0.4	0.4	0.4
Haziness (Deciview Improvement)	0.00	0.168	0.187	0.149	0.139	0.135
Control Costs and Cost/Benefit						
Capital Cost ($ millions)	-	-	-	-	-	-
Annual Operating and Maint. Cost ($ millions/year)	-	8.22	8.22	-	-	-
Levelized Annual Total Cost ($ millions/year)						2.88
Cost Benefit (Levelized Annual Cost per Deciview Change ($ millions/deciview)	N/A	$17.13	$15.37	$19.35	$20.75	$21.38

Measuring Visibility

Visibility can be impaired by one or more of the following atmospheric processes:

1. Light scattering by particles
2. Light scattering by gases
3. Light absorption by particles
4. Light absorption by gases

To fully understand and explain the relationship between these processes and visibility impairment requires extensive monitoring, at several locations while using several monitoring methods. Each of the above processes can be either measured or calculated individually or in the aggregate. The aggregate of these processes is called light extinction, and can be expressed using several different units. These include:

- Inverse kilometers - the fraction of light that is removed from a sight path per kilometer;

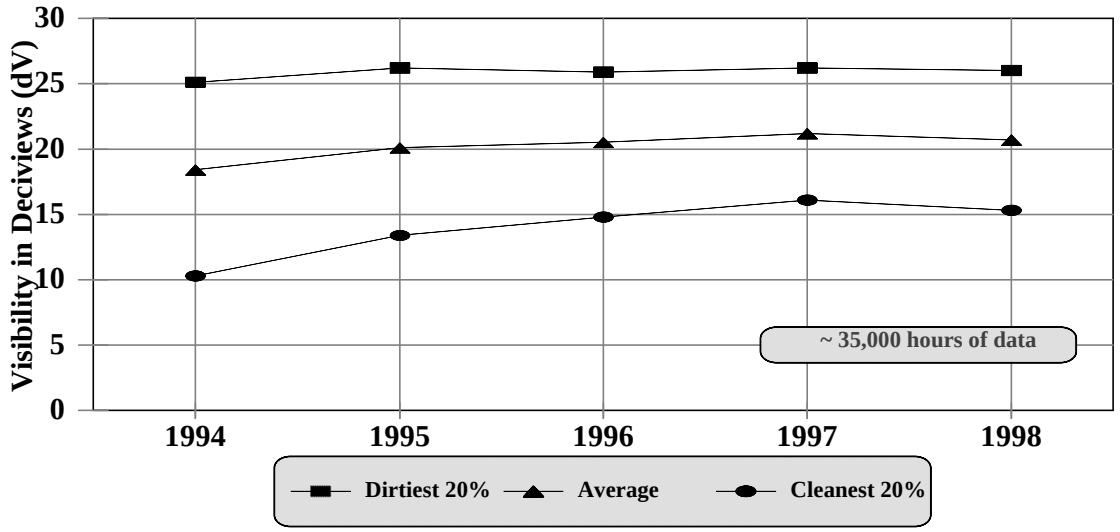
- Deciviews - a logarithmic scale reporting perceptible changes such that a higher number reports worse visual air quality (similar in concept to the decibel for sound); and

- Visual range - the distance which a dark object can be seen against a light horizon, expressed in miles or kilometers.

Deciviews has been chosen as the preferred way to express and compare overall visibility impairment by the Governor's Brown Cloud Summit. The primary method for continuous measurements of light extinction, representing visibility across the metropolitan area, is an instrument called a transmissometer. This device is comprised of a transmitter unit with calibrated incandescent light source, and a receiver unit, a telescope fitted with a photodetector. The resulting measurement is simply an expression of how much light does not travel the full distance from the source to the receiver. In Phoenix, a transmissometer has been in place over a 3 mile path from the roof of the Phoenix Baptist Hospital at 19th Avenue and Bethany Home Road to the roof of the Quality Hotel at 2nd Avenue and Osborn Road. Visibility data from the transmissometer which are affected by fog, rain and/or high humidity are excluded using a standardized protocol.

The figure below shows how transmissometer measurements have varied through time for the 20% dirtiest days, the average visibility day, and the cleanest 20%.

Light Extinction Trends
in the Phoenix Metropolitan Area



Measuring or estimating light scattering or light absorption separately requires a variety of approaches.

- Light scattering by gases, also known as Rayleigh scattering, can be calculated using a simple equation since it is a function of elevation, for the most part.

- Light absorbed by gases is almost exclusive to nitrogen dioxide, and can be estimated by measuring its concentration in the atmosphere and calculating light absorption from that value.

- Light scattering by particles is the most significant contributor to visibility impairment, and is therefore the most studied. Light scattering is measured by an instrument called a nephelometer. Nephelometers operate on the same principles as do transmissometers, except they use a short path for light to travel within a small climate-controlled chamber, rather than a long path through the ambient atmosphere.

- Light absorption by particles is caused by soot, also known as elemental carbon or black carbon. It is measured using an aethalometer, which captures soot on a tape and shines a light through it to determine how much is absorbed.

Visibility can also be characterized through more non-quantitative means using photography. Evaluating photography can provide insight into the structure of haze in the atmosphere, providing valuable information used in interpreting the measurements and calculations described above.

To determine the sources causing visibility impairment, light extinction measurements are compared to estimates of light extinction “reconstructed” from samples of particles captured on filters that have been analyzed chemically. Compounds in the atmosphere differ in how they scatter and/or absorb light. Therefore, light extinction coefficients are assigned to each compound, which are then multiplied by how much of each is measured on the filter, to, ultimately, provide an estimate of how much light each individual compound would scatter and/or absorb. These are then

added up to provide an estimate of total light extinction. In using this approach it is necessary to measure both fine particles (less than 2.5 microns) and coarse particles (2.5 to 10 microns). Presently, particle measurements are made at five locations in the Phoenix area, which have been used in assessing visibility impairment. These same measures can also be used to identify sources of visibility impairment. The scientific method and analytical results of reconstructed light extinction is discussed in Appendix 3.

Sources of Fall and Winter Visibility Impairment in Phoenix

Prepared for the

Arizona Department of Environmental Quality

ENSR Document 0493-018-20

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FIGURES

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1. INTRODUCTION AND SUMMARY

The Arizona Department of Environmental Quality (ADEQ) has implemented a network to monitor visibility and related pollutants on a long-term basis in the Phoenix urban area (Moore, 1999). This document describes the attribution of visibility impairment to sources using data from this network. The attribution was performed for measurements available during the fall and winter (September through February), which is the time of the year when visibility impairment is most severe in Phoenix.

A loss of clarity in the air can be described through a parameter known as "light extinction". Total light extinction consists of the sum of the following four components:

1. Light scattering by gases - termed Rayleigh or natural scattering which is not related to air pollution.

2. Light absorption by gases - nitrogen dioxide (NO_2) is the only gas normally present in urban areas which absorbs significant quantities of visible light.

3. Light scattering by particles - numerous field studies of urban visibility, including studies in the Phoenix and Tucson areas, have shown that particles less than or equal to 2.5 microns (µm) in aerodynamic diameter ($PM_{2.5}$) cause the vast majority of light scattering, although particles between 2.5 µm and 10 µm diameter (coarse particles) also scatter light.

4. Light absorption by particles - which is dominated by elemental carbon (soot).

Light extinction data can be reported three ways:

1. Visual Range (VR) - Visual range is an expression of visibility impairment defined as the distance in miles or kilometers at which a large black object just disappears from view. Visual range values are calculated from direct measurement data, or are estimated directly by weather observers.

2. Inverse megameter (Mm^{-1}) - The inverse megameter is the direct measurement unit for visibility impairment data, and the values measured by field instruments report the proportion of the amount of light scattered and absorbed as it travels over a distance of one million meters. Inverse megameters can be transformed into deciviews or visual range.

3. Deciview (dv) - The deciview is a visual index designed to be linear with respect to perceived visual air quality changes over its entire range in a way that is analogous to the decibel index for sound. The deciview scale is zero for pristine conditions and increases as visibility degrades. Every one deciview change represents a perceptible change in visual air

quality to the average person; this is approximately a 10% change in the inverse megameter reading. The deciview values are calculated from the measurement data and are defined as:

$$dv = 10 \ln(b_{ext}/10) \quad (1\text{-}1)$$

where b_{ext} is the light extinction coefficient in Mm^{-1} and ln is the natural logarithm.

The following steps were used for the source attribution:

1. Visibility impairment caused by measured pollutant concentrations was calculated using pollutant-specific light extinction efficiencies that were developed during the 1989-90 Phoenix Winter Haze Study (Watson, et. al, 1991) using data specific to Phoenix.. The pollutant concentrations were measured from 5:00 am to 11:00 am MST between December 1994 and September 1996 at three locations in the Phoenix metropolitan area (the Super Site at 4530 North 17th Avenue in central Phoenix, the Tempe site at 3340 South Rural Road, and the ASU West site at 47th Avenue & Thunderbird Road at Arizona State University).

2. The pollutant concentrations were attributed to broad source categories using receptor modeling.

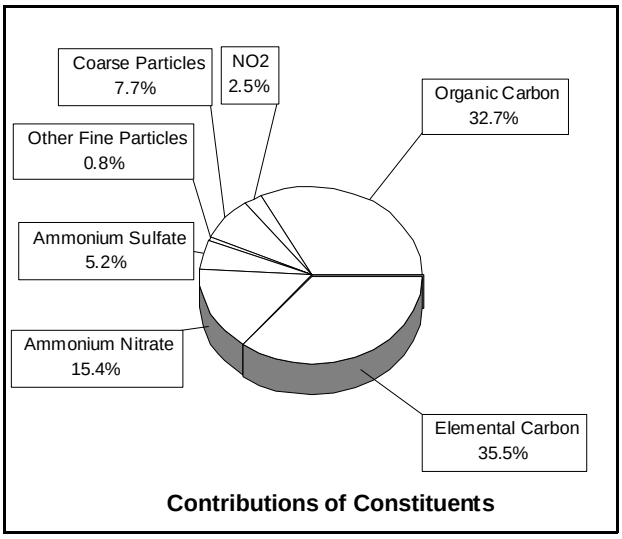
3. The contributions of sources to pollutant concentrations were used with contributions of the pollutant concentrations to visibility impairment to attribute visibility impairment to the broad source categories

4. The contributions to visibility impairment from broad source categories that could not be resolved into subcategories were attributed to subcategories in proportion to emissions

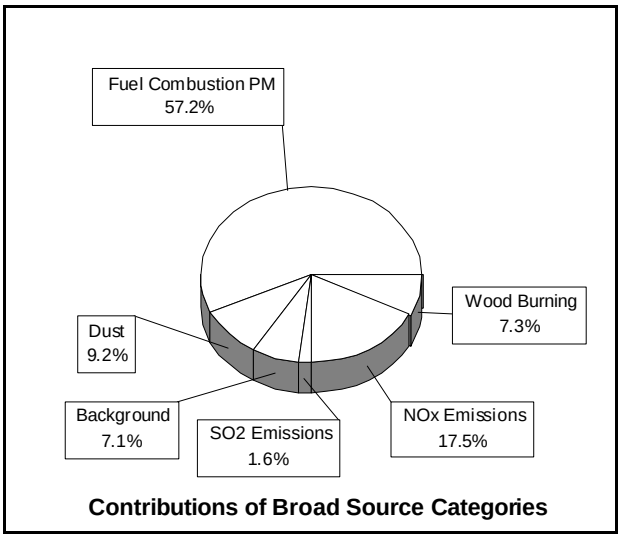
Figure 1-1 summarizes the results from these steps for the 20 percent worst-visibility days. As seen in the figure, organic compounds and elemental carbon in particles account for most of the visibility impairment during these days, followed by ammonium nitrate, which is formed by reactions in the atmosphere that convert gaseous nitrogen oxide and ammonia emissions to ammonium nitrate in particles. The figure also shows that particles emitted during fossil-fuel combustion (gasoline, diesel fuel and natural gas combustion), which are more than 90 percent organic compounds and elemental carbon, account for more than half of the visibility impairment. Gasoline-fueled engines contribute about 37 percent of the visibility impairment, while diesel-fueled engines contribute about 16 percent.

Figure 1-1. Average Contributions to Fall and Winter Visibility Impairment During the Worst 20 Percent Days

The chart to the right shows the contributions of measured pollutant concentrations. Organic carbon, elemental carbon and ammonium nitrate are the major contributors. The average visibility impairment during these worst days was 28.7 deciviews. The pollutant concentrations were measured from 5:00 am to 11:00 am MST at the Phoenix Super Site, at Tempe and at ASU West.



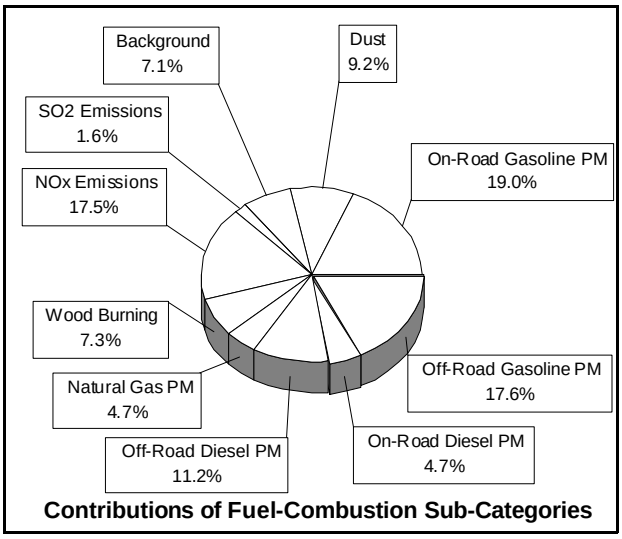
Contributions of Constituents



Contributions of Broad Source Categories

The chemical mass balance receptor model was used to apportion the measured pollutant concentrations to broad source categories so that the contributions of the source categories to visibility impairment could be calculated. The chart to the left shows the average source category contributions during the same days that are included in the first box. Particles from fossil fuel combustion (gasoline, diesel and natural gas) are the major contributors, followed by nitrogen oxide (NO_X) emissions, which are also from fossil fuel combustion.

An inventory of emissions of particles from fossil fuel combustion sub-categories was used to apportion the fossil fuel combustion contributions in the box above to on- and off-road gasoline and diesel-fueled engines and to natural gas combustion. The chart on the right shows the results. Particles from gasoline-fueled engines contribute about 37 percent of the visibility impairment on these worst days, while diesel-fueled engines contribute about 16 percent. Additionally, although not shown, NO_X emissions from diesel-fueled engines contribute about 9 percent, and NO_X from gasoline-fueled engines contributes about 7 percent.



Contributions of Fuel-Combustion Sub-Categories

Details of the analyses are described in the following sections. Section 2 describes the measurements that were used for the analysis. Section 3 presents the approach used to apportion visibility impairment to pollutant concentrations, and Section 4 presents the approach used to apportion pollutant concentrations to source categories. Section 5 presents the approach used to apportion visibility impairment to sources.

2. DESCRIPTION OF MEASUREMENTS

The source attribution utilized measurements made between December 1994 and September 1996. Data from the fall (September through November) and the winter (December through February) were used, because visibility impairment is worse during these seasons than the rest of the year.

The measurements included filter samples of particles smaller than 2.5 µm diameter ($PM_{2.5}$) and particles between 2.5 µm and 10 µm diameter (coarse particles) at three locations:

1. The Super Site at 4530 North 17th Avenue in central Phoenix;

2. The Tempe site at 3340 South Rural Road; and

3. The ASU West site at 47th Avenue & Thunderbird Road at Arizona State University

Samples were collected between 5 am and 11 am every sixth day. This time period was used because visibility impairment is worse during the morning than the afternoon. $PM_{2.5}$ samples were analyzed for mass, light transmittance and chemical composition. The chemical analyses included organic and elemental carbon by the thermal optical reflectance (TOR) method, sulfate and nitrate by ion chromatography (IC) and chemical elements by x-ray fluorescence (XRF). Samples of coarse particles were analyzed for mass.

NO_2 was measured continuously at the Super Site. Relative humidity, which affects the visibility impairment caused by some pollutants, was measured continuously at the transmissometer receiver on the roof of the Quality Hotel at 3600 North Second Avenue.

3. CONTRIBUTIONS OF POLLUTANTS TO VISIBILITY IMPAIRMENT

The approach to calculating visibility impairment by pollutants followed the procedures developed by Watson, et. al (1991) during the 1989-90 Phoenix Urban Haze Study. Although other approaches have been developed for other locations, such as by Sisler and Malm (2000) for the IMPROVE (Interagency Monitoring of PROtected Visual Environments) program, operated by the National Park Service, the approach developed by Watson et. al is specific to Phoenix and based on measurements made in the Phoenix area. Therefore, it is expected to calculate contributions to light extinction from pollutants in Phoenix better than other approaches would.

For each particle sampling period with valid data, visibility impairment was calculated for:

1. Light scattering by $PM_{2.5}$ organic compounds
2. Light scattering by $PM_{2.5}$ elemental carbon
3. Light scattering by $PM_{2.5}$ ammonium nitrate
4. Light scattering by $PM_{2.5}$ ammonium sulfate
5. Light scattering by "other" $PM_{2.5}$ ($PM_{2.5}$ not accounted for by organic compounds, elemental carbon, ammonium nitrate or ammonium sulfate)
6. Light scattering by coarse particles
7. Light absorption by elemental carbon
8. Light absorption by NO_2
9. Light scattering by air molecules

The light scattering caused by each particulate pollutant was calculated using light scattering efficiencies, which are the light extinction coefficients, in inverse megameters, caused by an atmospheric concentration of one microgram per cubic meter of air ($\mu g/m^3$). The light scattering efficiencies vary from one pollutant to another because of differences in the sizes of the particles in which the pollutants are found as well as differences in refractive indices. Additionally, organic compounds, ammonium nitrate and ammonium sulfate can absorb water vapor from the atmosphere, so extinction efficiencies depend on relative humidity.

The following light scattering efficiencies, developed during the 1989-90 Phoenix Winter Haze Study by Watson, et. al (1991) were used:

$$a_{\text{organic compounds}} = 3.4 + [0.6/(1\text{-}RH/100)]\ m^2/g \quad (3\text{-}1)$$

$$a_{\text{elemental carbon}} = 1.6\ m^2/g \quad (3\text{-}2)$$

$$a_{\text{ammonium nitrate}} = 1.8 + [1.3/(1\text{-}RH/100)]\ m^2/g \quad (3\text{-}3)$$

$$a_{\text{ammonium sulfate}} = 1.0 + [1.0/(1\text{-}RH/100)]\ m^2/g \quad (3\text{-}4)$$

$a_{other\ PM2.5}$ = 1.0 m^2/g (3-5)

$a_{coarse\ particles}$ = 0.4 m^2/g (3-6)

where:

$a_{organic\ compounds}$ = light scattering efficiency for $PM_{2.5}$ organic compounds
$a_{elemental\ carbon}$ = light scattering efficiency for elemental carbon
$a_{ammonium\ nitrate}$ = light scattering efficiency for ammonium nitrate
$a_{ammonium\ sulfate}$ = light scattering efficiency for ammonium sulfate
$a_{other\ PM2.5}$ = light scattering efficiency for other $PM_{2.5}$ mass
$a_{coarse\ particles}$ = light scattering efficiency for coarse particles

The mass concentration of organic compounds was calculated by multiplying the measured organic carbon concentration by 1.2 to account for hydrogen and oxygen associated with the carbon (Watson, et. al, 1991). Ammonium nitrate and ammonium sulfate concentrations were calculated by multiplying the measured nitrate and sulfate ion concentrations by 1.29 and 1.375, respectively, to account for the ammonium. Concentrations of the other $PM_{2.5}$ mass were calculated by subtracting the calculated organic compound, elemental carbon, ammonium nitrate and ammonium sulfate concentrations from the measured $PM_{2.5}$ mass concentrations. In some cases, the resulting value was negative because of measurement uncertainties. The other $PM_{2.5}$ concentration was set to zero in those cases.

The hourly average relative humidity values measured at the transmissometer receiver in downtown Phoenix, averaged over the six-hour particle sample collection periods, were used in Equations 3-1, 3-3 and 3-4. Light extinction was only calculated for periods when at least five valid hourly average relative humidity values were available. Additionally, in order to avoid periods of fog, hourly average relative humidity values that exceeded 90 percent were eliminated.

Because elemental carbon dominates light absorption by particles in urban atmospheres, the measured light absorption coefficient was attributed entirely to elemental carbon.

The value of 0.21 Mm^{-1}/part-per-million-volume (ppbv) for light absorption by NO_2 developed by Watson, et. al. (1991) was used. Because NO_2 data were only available from the Super Site, these data were used to represent concentrations at all three of the particulate matter monitoring sites. Light extinction was calculated only for particle sampling periods with at least four hours of valid NO_2 data.

The light scattering value of 13 Mm^{-1} for air molecules, developed by Watson, et. al. (1991) for the elevation in Phoenix, was also used.

The following equation summarizes the calculations:

b_{ext} = $(a_{organic\ compounds})$ 1.2 [OC] + $(a_{elemental\ carbon})$ [EC] +

$$(a_{\text{ammonium nitrate}})\ 1.29\ [NO_3] + (a_{\text{ammonium sulfate}})\ 1.375\ [SO_4] + (a_{\text{other PM2.5}})\ [\text{Other } PM_{2.5}] + (a_{\text{coarse particles}})\ [\text{coarse particles}] + b_{abs} + 0.21\ [NO_2] + 13 \quad (3\text{-}7)$$

where:

b_{ext}	=	calculated light extinction coefficient [Mm^{-1}]
[OC]	=	measured organic carbon concentration [$\mu g/m^3$]
[EC]	=	measured elemental carbon concentration [$\mu g/m^3$]
$[NO_3]$	=	measured nitrate concentration [$\mu g/m^3$]
$[SO_4]$	=	measured sulfate concentration [$\mu g/m^3$]
[Other $PM_{2.5}$]	=	concentration of other $PM_{2.5}$ particles [$\mu g/m^3$]
[coarse particles]	=	measured concentration of coarse particles [$\mu g/m^3$]
b_{abs}	=	measured light absorption coefficient [Mm^{-1}]
$[NO_2]$	=	measured NO_2 concentration [ppbv]

Figures 3-1 through 3-3 show the average contributions of the constituents, averaged over all three monitoring sites, for the best 20 percent of the days (the 20 percent of the days with the lowest calculated light extinction coefficient), the middle 60 percent of the days, and the worst 20 percent of the days, respectively. The contribution from light scattering by air molecules is not shown in the figures, so the percentages represent the relative contributions to visibility impairment, rather than to the total light extinction coefficient. However, the average deciview values in the figures include the contribution from air molecules. The averages over the three sites were calculated by first calculating the average values for the various ranges for each site individually, and then averaging those three values. For example, the average over the three sites for the 20 percent worst days was calculated by first calculating the average values for the 20 percent worst days at each site. Those three values were then averaged.

As seen in the figures, organic compounds and elemental carbon dominate the calculated visibility impairment, accounting for about 70% during all three ranges of impairment. Ammonium nitrate tends to contribute more during the worst days than on other days.

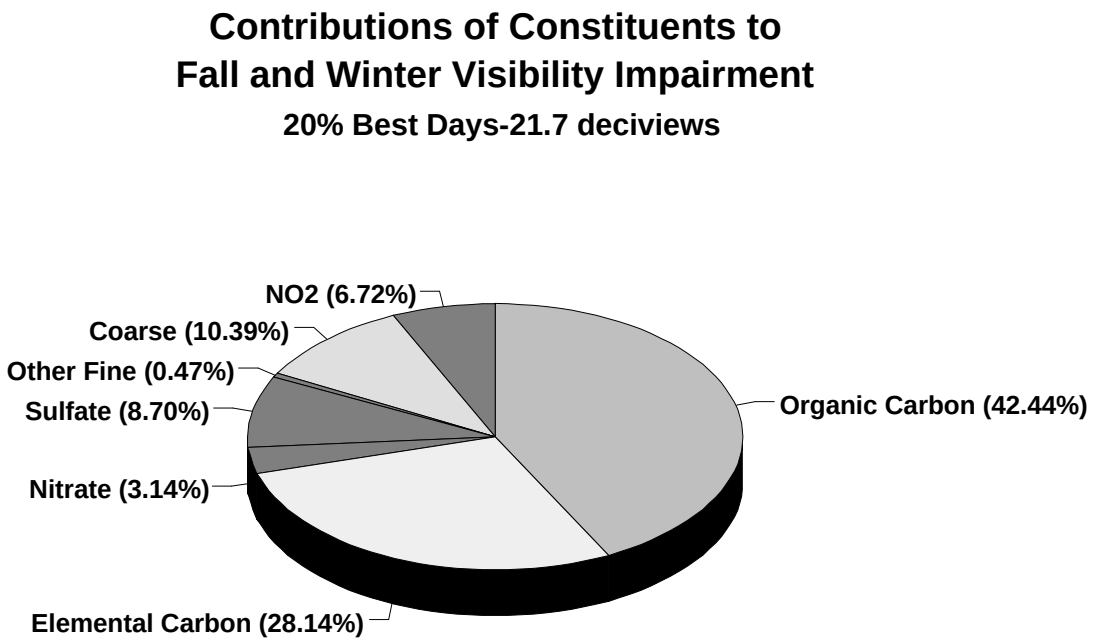


Figure 3-1. Contributions of Constituents to Fall and Winter Visibility Impairment During the Best 20 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

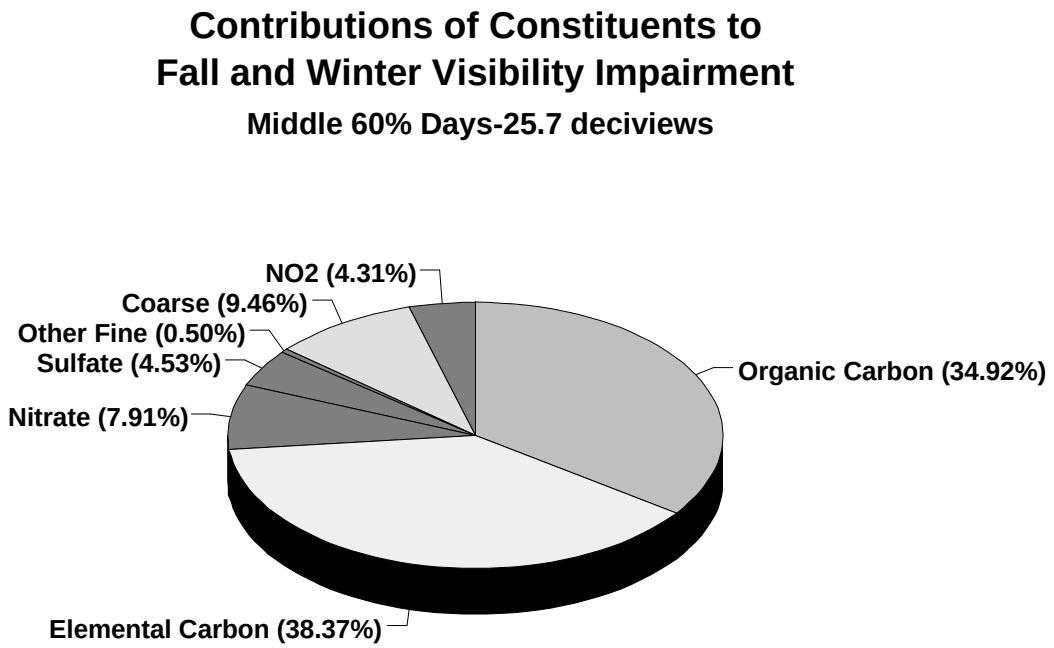


Figure 3-2. Contributions of Constituents to Fall and Winter Visibility Impairment During the Best 20 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

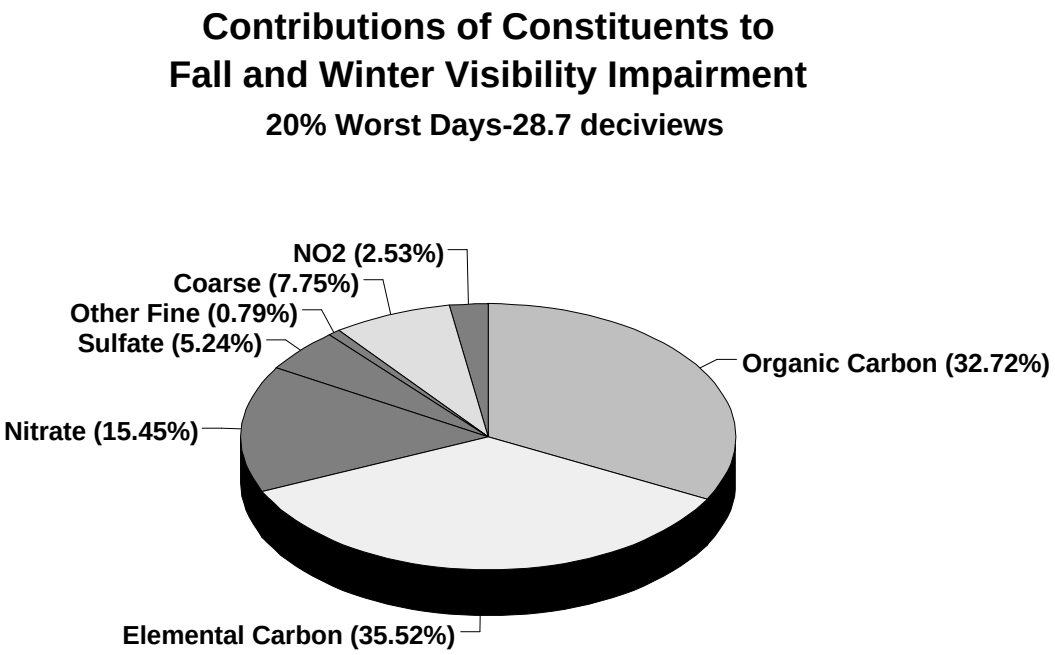


Figure 3-3. Contributions of Constituents to Fall and Winter Visibility Impairment During the Best 20 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

4. CONTRIBUTIONS OF SOURCES TO POLLUTANTS

Receptor modeling was used to attribute $PM_{2.5}$ constituent concentrations to the following broad source categories:

- Emissions of geological materials (primarily fugitive dust)
- Fossil-fuel combustion
- Wood burning
- Secondary ammonium nitrate, formed from atmospheric chemical reactions of nitrogen oxide (NO_X) emissions
- Secondary ammonium sulfate, formed from atmospheric chemical reactions of sulfur dioxide (SO_2) emissions

Previous receptor modeling in Phoenix during the 1989-90 Phoenix Urban Haze Study (Watson, et. al, 1991) showed that coarse particles are almost exclusively from emissions of geological materials, so the measured coarse particle mass concentrations were attributed completely to this category. NO_2 concentrations and the resulting visibility impairment were attributed to NO_X emission sources.

Background concentrations of organic and elemental carbon, ammonium nitrate and ammonium sulfate in the air entering the Phoenix area were also estimated. These constituents have been measured at remote Sonoran Desert locations at Chiricahua National Monument and at Tonto National Monument as part of the IMPROVE network. Average fall and winter concentrations measured at these two locations are listed in Table 4-1 along with the average fall and winter concentrations for Phoenix.

As seen in the table, with the exception of ammonium sulfate, concentrations measured at the remote sites are substantially lower than measured in Phoenix. The average organic and elemental carbon concentrations measured at Tonto National Monument are almost twice as high as at Chiricahua National Monument. Tonto National Monument is relatively close to Phoenix and frequently downwind of the metropolitan area during the daytime, when winds tend to be from the west to southwest. Therefore, it is likely that concentrations in Tonto National Monument are influenced by transport from Phoenix. Therefore, the average concentrations measured at Chiricahua were used to represent background levels.

Table 4-1. Average Fall And Winter Concentrations in Phoenix, Tonto National Monument and Chiricahua National Monument

Constituent	Phoenix	Tonto National Monument[a]	Chiricahua National Monument[a]
$PM_{2.5}$ Mass ($\mu g/m^3$)	14.8	4.74	3.39
Organic Carbon ($\mu g/m^3$)	6.88	1.03	0.59
Elemental Carbon ($\mu g/m^3$)	3.46	0.29	0.15
Ammonium Nitrate ($\mu g/m^3$)	1.60	0.33	0.12
Ammonium Sulfate ($\mu g/m^3$)	2.17	1.46	1.45

[a] From IMPROVE monitoring network

The receptor modeling approach used measured concentrations of $PM_{2.5}$ chemical constituents along with the mass fractions of these constituents in $PM_{2.5}$ emissions to calculate contributions of the emission sources to the $PM_{2.5}$ mass concentration, as follows:

1. Iron in $PM_{2.5}$ comes essentially exclusively from emissions of geological materials. Therefore, the measured atmospheric $PM_{2.5}$ iron concentration was divided by the mass fraction of iron in geological materials in the Phoenix area to calculate the contribution of geological materials to $PM_{2.5}$ mass.

2. Water soluble potassium comes primarily from wood burning. Therefore, the measured atmospheric $PM_{2.5}$ water soluble potassium concentration was divided by the mass fraction of water soluble potassium in wood burning $PM_{2.5}$ emissions to calculate the contribution of wood burning to $PM_{2.5}$ mass. It should be noted, however, that other emissions from other sources, such as agricultural soils fertilized with potassium-containing fertilizers, may contain some water-soluble potassium. Therefore, the calculated contributions from wood burning should be considered an upper-limit estimate. However, as shown later, the estimated wood burning contribution to visibility impairment was relatively small (less than about seven percent), so the uncertainties in the estimates of its contributions do not substantially affect the conclusions from the analyses. The wood burning contribution was only calculated for samples collected during the winter, since summertime fireplace use is negligible in metropolitan Phoenix..

3. Elemental carbon comes from wood burning, fossil-fuel combustion, and the background air entering the area. The contribution from fossil-fuel combustion was calculated by

subtracting the contributions from the background air and from wood burning from the measured concentration. The contribution from wood burning was calculated by multiplying the contribution of wood burning to $PM_{2.5}$ mass, calculated in step 2, by the mass fraction of elemental carbon in wood burning $PM_{2.5}$ emissions. The elemental carbon concentration from fossil-fuel combustion was then divided by the mass fraction of elemental carbon in fossil-fuel combustion $PM_{2.5}$ emissions to calculate the contribution of fossil-fuel combustion to $PM_{2.5}$ mass. As discussed above, the contribution from wood burning may be overestimated somewhat, which could lead to an underestimation of the contribution from fossil-fuel combustion. However, the this underestimation should be minor, because the estimated contribution from wood combustion is small.

4. Nitrate and sulfate come from secondary ammonium nitrate and ammonium sulfate formed from local nitrogen oxide and sulfur dioxide emissions, respectively, from wood burning, and from the background air entering the area. The contributions from the background and from wood burning were subtracted from the measured atmospheric $PM_{2.5}$ concentrations, and the remainder was attributed to secondary ammonium nitrate and sulfate from local NO_X and SO_2 emissions.

These contributions to $PM_{2.5}$ mass concentrations were then multiplied by the mass fractions of organic and elemental carbon, ammonium nitrate, ammonium sulfate and "other" $PM_{2.5}$ mass to calculate the contributions of the emission sources to the visibility impairing constituents.

The emission compositions used in these calculations are listed in Table 4-2. The compositions for geological materials and wood burning were those found by Watson, et., al. (1991) to provide the best results for the 1989-90 Phoenix Urban Haze Study. The elemental and organic carbon concentrations in fuel-combustion emissions were derived from the 1995 $PM_{2.5}$ emissions inventory for the Metropolitan Phoenix area presented by George (2000). This inventory was constructed from the 1995 base-case inventory to equalize the ratio of elemental and organic carbon of the emissions with their ratio in the ambient air. Discussed fully in a separate appendix, this adjustment retains the experimentally determined elemental to organic carbon ratios of recent vehicular testing. This adjustment increases the total particulate matter emissions from gasoline combustion and decreases the total particulate matter emissions from diesel fuel combustion to achieve the desired ambient ratio. With this adjusted inventory, the elemental and organic carbon emissions from fossil-fuel combustion in the inventory were divided by the total $PM_{2.5}$ emissions from fossil fuel combustion to calculate the mass fractions in Table 4-2.

Table 4-2. Chemical Constituent Mass Fractions in $PM_{2.5}$ Emissions

Species	Geological Materials[a]	Wood Burning[b]	Fossil-Fuel Combustion[c]	Secondary Ammonium Nitrate[d]	Secondary Ammonium Sulfate[d]
Organic Carbon	0.0376	0.446	0.587	0.00	0.00
Elemental Carbon	0.00	0.159	0.342	0.00	0.00
Nitrate	0.00	0.0046	0.00	0.775	0.00
Sulfate	0.00	0.0142	0.00	0.00	0.727
Iron	0.0363	0.00	0.00	0.00	0.00
Water Soluble Potassium	0.00	0.0399	0.00	0.00	0.00
"Other" $PM_{2.5}$[e]	0.955[f]	0.280	0.00	0.00	0.00

[a] Composite geological derived from Watson, et. al., 1991
[b] Bakersfield fireplace (Watson, et. al, 1991)
[c] Derived from 1995 Phoenix $PM_{2.5}$ emissions inventory presented by George (2000)
[d] From molecular formula
[e] "Other" $PM_{2.5}$ = 1 - 1.2 x organic carbon - elemental carbon - 1.29 x nitrate - 1.375 x sulfate
[f] Iron is included in the "Other" $PM_{2.5}$ component, so the sum of the fractions for geological material exceeds one.

5. CONTRIBUTIONS OF SOURCES TO VISIBILITY IMPAIRMENT

The contributions of the emission source categories to visibility impairment were calculated by apportioning the contributions of the pollutants to visibility impairment in proportion to the contributions of the sources to the pollutants. These calculations were made for each source category as follows:

1. For each visibility-impairing pollutant, the visibility impairment from the pollutant was multiplied by the fraction of the mass concentration of the pollutant attributed to the source category. The fraction of the pollutant's mass concentration attributed to the source category was calculated by dividing the mass concentration of the pollutant attributed to the source, calculated as described in the previous section, by the total mass concentration of the pollutant calculated by the receptor modeling. This division by the calculated mass concentration, instead of the measured mass concentration, is necessary because uncertainties in the receptor modeling lead to differences between calculated and measured pollutant concentrations.

2. The results from step 1 for each visibility-impairing pollutant were added together to calculate the total visibility impairment attributed to the source category.

Mathematically, these calculations are represented by:

$$S_i = \sum_j V_j (C_{i,j} / \sum_k C_{k,j}) \quad (5\text{-}1)$$

where:

S_i = contribution of source i to visibility impairment (Mm^{-1})
$C_{i,j}$ = contribution of source i to pollutant j ($\mu g/m^3$)
V_j = visibility impairment caused by pollutant j (Mm^{-1})

The average source category contributions to fall and winter visibility impairment during the 20 percent best days, the middle 60 percent of the days and the 20 percent worst days are shown in Figures 5-1 through 5-3, respectively. As seen, fossil-fuel combustion $PM_{2.5}$ emissions dominate visibility impairment, contributing about 60 percent during all theree types of days. Contributions from wood burning $PM_{2.5}$ emissions vary from about one percent to about seven percent. Contributions from NO_X and SO_2 emissions vary from about nine percent to 18 percent and from about one percent to about four percent, respectively. The background contribution varies from about seven percent to about 20 percent. The percentages contributed by background concentrations and by local SO_2 emissions are higher during the best days and lower during the worst days.

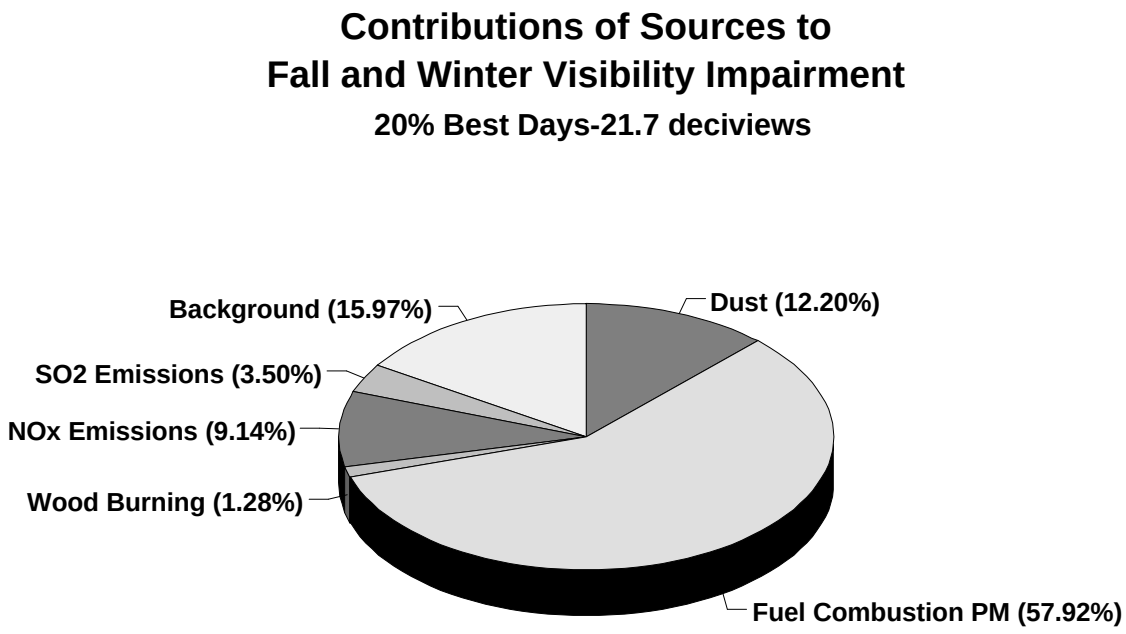


Figure 5-1. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Best 20 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

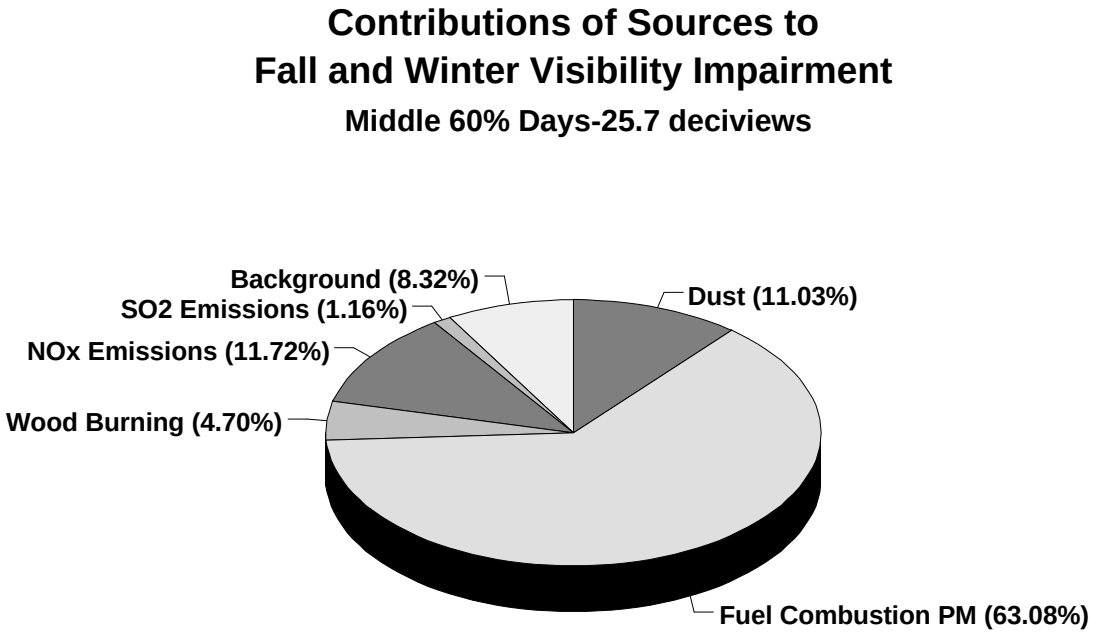


Figure 5-2. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Middle 60 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

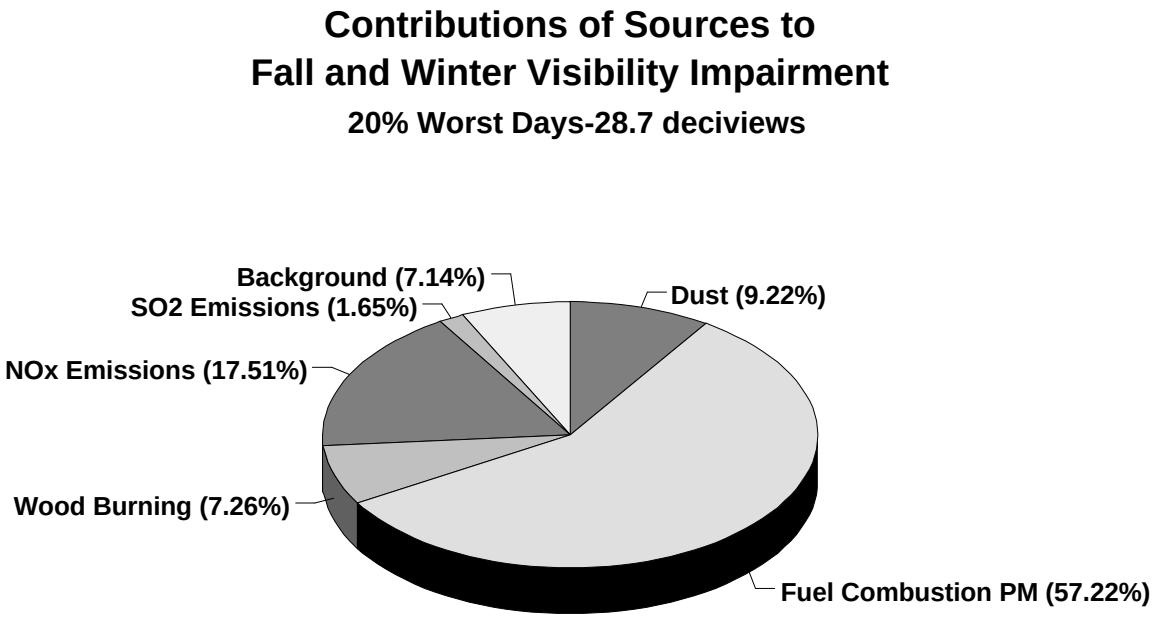


Figure 5-3. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Worst 20 Percent Days. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

The contributions from fossil-fuel combustion $PM_{2.5}$ emissions were attributed to the following fuel-combustion subcategories in proportion to emissions:

- On-road gasoline-fueled vehicles
- Off-road gasoline-fueled engines, such as lawn and garden equipment
- On-road diesel-fueled vehicles
- Off-road diesel-fueled engines, such as construction equipment
- Natural gas combustion, such as industrial engines and boilers, and commercial and residential space heaters

This attribution was done separately for organic and elemental carbon emissions to account for differences among source categories in the relative proportions of organic and elemental carbon in their emissions. For each of the above subcategories, the contributions to visibility impairment of organic and elemental carbon attributed to fossil-fuel combustion were multiplied by the fractions of fossil-fuel combustion organic and elemental carbon emissions from the subcategory. These two values were then added together to calculate the visibility impairment from the subcategory. This calculation is represented by the following equation:

$$S_{i,s} = (f_{i,s,OC} V_{OC} C_{ff,OC} / \Sigma_j C_{j,OC}) + (f_{i,s,EC} V_{EC} C_{ff,EC} / \Sigma_j C_{j,EC}) \quad (5\text{-}2)$$

where:

$S_{i,s}$ = contribution of fossil-fuel combustion subcategory i to visibility impairment (Mm^{-1})
$f_{i,s,OC}$ = fraction of fossil-fuel combustion organic carbon emissions from subcategory i
V_{OC} = visibility impairment from organic carbon (Mm^{-1})
$C_{ff,OC}$ = contribution of fossil-fuel combustion $PM_{2.5}$ emissions to organic carbon concentration calculated from receptor modeling ($\mu g/m^3$)
$C_{j,OC}$ = contribution of source category j to organic carbon concentration calculated from receptor modeling ($\mu g/m^3$)
$f_{i,s,EC}$ = fraction of fossil-fuel combustion elemental carbon emissions from subcategory i
V_{EC} = visibility impairment from elemental carbon (Mm^{-1})
$C_{ff,EC}$ = contribution of fossil-fuel combustion $PM_{2.5}$ emissions to elemental carbon concentration calculated from receptor modeling ($\mu g/m^3$)
$C_{j,EC}$ = contribution of source category j to elemental carbon concentration calculated from receptor modeling ($\mu g/m^3$)

The percentages of fossil fuel organic and elemental carbon emissions from each of the subcategories, calculated from the 1995 $PM_{2.5}$ emissions inventory presented by George (2000), are listed in Table 5-1. As seen in the table, gasoline combustion is estimated to account for the majority of the fossil-fuel combustion $PM_{2.5}$ organic carbon emissions, while gasoline and diesel-fuel combustion account for about the same amount of fossil-fuel combustion $PM_{2.5}$ elemental

carbon emissions.

Table 5-1. Contributions of Fossil-Fuel Combustion Subcategories to 1995 Fossil-Fuel Combustion Organic and Elemental Carbon $PM_{2.5}$ Emissions

Fossil-Fuel Combustion Subcategory	Percent of Fossil-Fuel Combustion Organic Carbon $PM_{2.5}$ Emissions	Percent of Fossil-Fuel Combustion Elemental Carbon $PM_{2.5}$ Emissions
On-Road Gasoline-Fueled Vehicles	41.9	26.1
Off-Road Gasoline-Fueled Engines	40.8	22.7
On-Road Diesel Fueled Vehicles	2.1	13.1
Off-Road Diesel Fueled Engines	4.6	31.7
Natural Gas Combustion	10.6	6.3

Source: Adapted from George (2000)

The resulting average fossil-fuel combustion $PM_{2.5}$ emissions subcategory contributions to fall and winter visibility impairment during the 20 percent best days, the middle 60 percent of the days and the 20 percent worst days are shown in Figures 5-4 through 5-6, respectively. As seen, $PM_{2.5}$ emissions from gasoline combustion account for about 40 percent of the visibility imapirment, $PM_{2.5}$ emissions from diesel-fuel combustion account for about 15 percent, and $PM_{2.5}$ emissions from natural gas combustion account for about five percent.

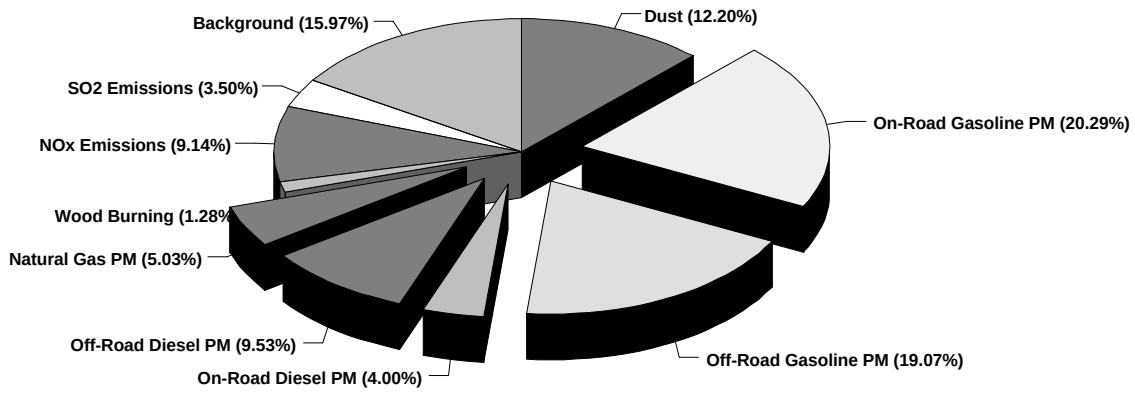


Figure 5-4. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Best 20 Percent Days Showing Contributions of Fossil-Fuel Combustion $PM_{2.5}$ Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

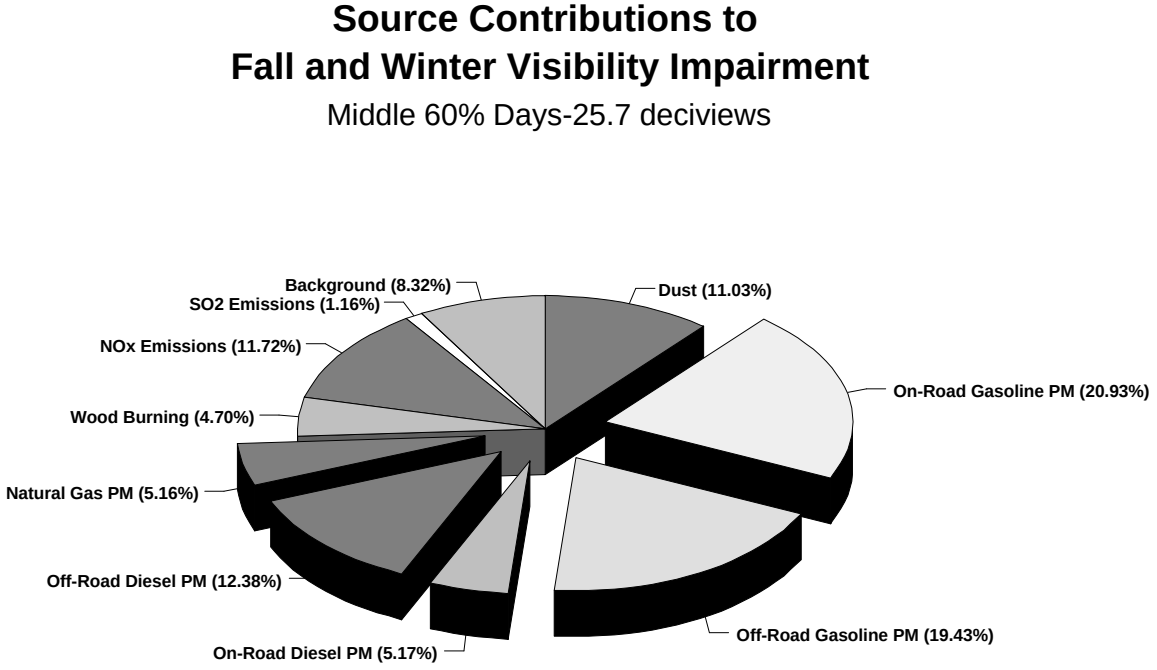


Figure 5-5. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Middle 60 Percent Days Showing Contributions of Fossil-Fuel Combustion $PM_{2.5}$ Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

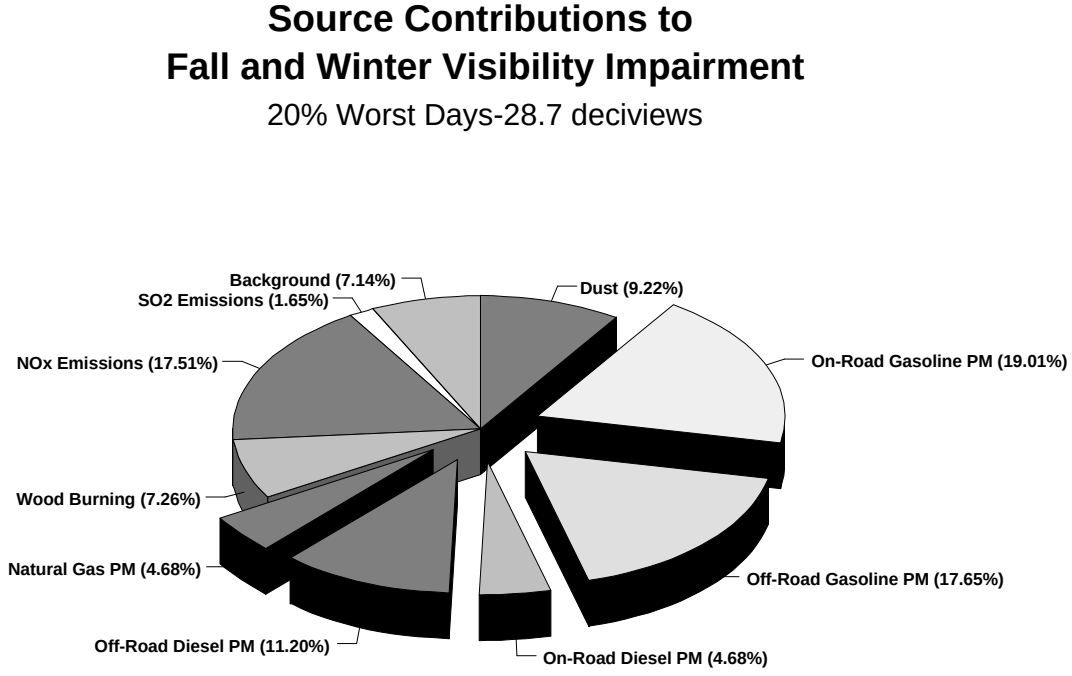


Figure 5-6. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Worst 20 Percent Days Showing Contributions of Fossil-Fuel Combustion $PM_{2.5}$ Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

A similar approach was used to apportion visibility impairment from nitrogen oxide (NO_X) emissions to fossil-fuel combustion subcategories. For each subcategory, the contribution of NO_X emissions to visibility impairment was multiplied by the fraction of NO_X emissions from the subcategory. These fractions, adapted from the 1995 emissions inventory for the Revised MAG 1999 Serious Area Particulate Plan for PM-10 for the Maricopa County Nonattainment Area (MAG, 1999) are listed in Table 5-2. Gasoline combustion accounts for about 30 percent of the NO_X emissions, while diesel-fuel combustion accounts for about 50 percent.

Table 5-2. Contributions of Fossil-Fuel Combustion Subcategories to 1995 Nitrogen Oxide Emissions

Fossil-Fuel Combustion Subcategory	Percent of Nitrogen Oxide Emissions
On-Road Gasoline-Fueled Vehicles	39.6
Off-Road Gasoline-Fueled Engines	0.4
On-Road Diesel Fueled Vehicles	17.8
Off-Road Diesel Fueled Engines	33.8
Natural Gas Combustion	8.5

Source: Adapted from MAG (1999)

The resulting average fossil-fuel combustion NO_X emissions subcategory contributions to fall and winter visibility impairment during the 20 percent best days, the middle 60 percent of the days and the 20 percent worst days are shown in Figures 5-7 through 5-9, respectively.

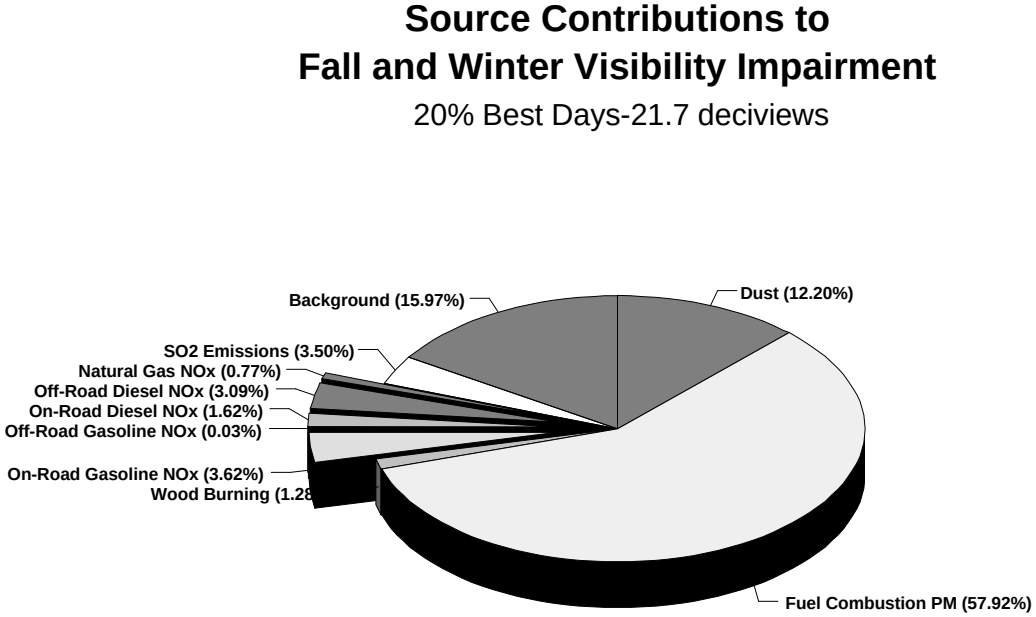


Figure 5-7. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Best 20 Percent Days Showing Contributions of Fossil-Fuel Combustion NO_X Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

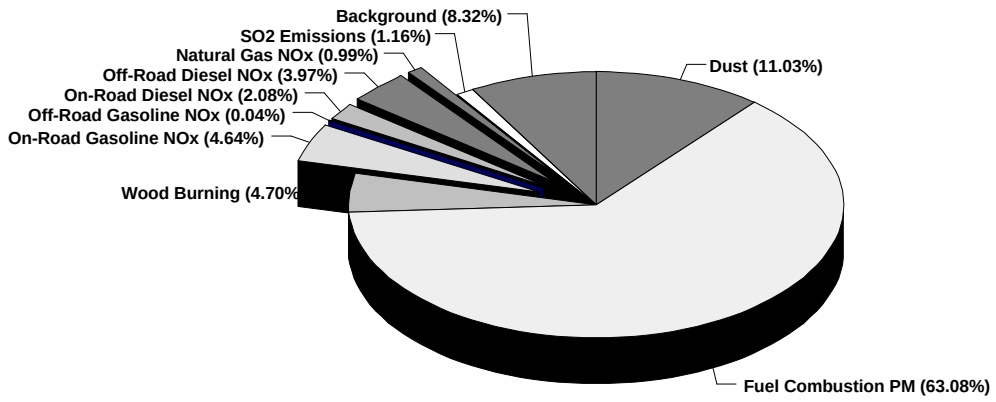


Figure 5-8. Contributions of Source Categories to Fall and Winter Visibility Impairment During the Middle 60 Percent Days Showing Contributions of Fossil-Fuel Combustion NO_X Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

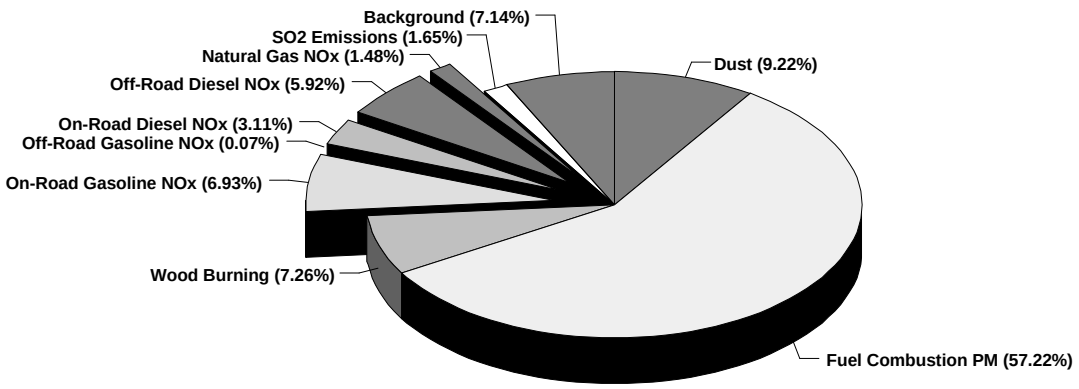


Figure 5-9. Contributions of Source Categories to Fall and Winter Visibility Impairment During the 20 Percent Worst Days Showing Contributions of Fossil-Fuel Combustion NO_X Emission Subcategories. The values are averages over the three monitoring sites (Super Site, Tempe and ASU West) and are based on samples collected from 5:00 am to 11:00 am MST.

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FINAL REPORT
VISIBILITY STANDARD RECOMMENDATIONS WORKING GROUP
VISIBILITY STANDARD SUBCOMMITTEE
GOVERNOR'S BROWN CLOUD SUMMIT

Background

The Visibility Standard Subcommittee was established by the Governor's Brown Cloud Summit at their meeting of August 8, 2000, to fulfill the following charge:

"*The goal of the Visibility Standard Subcommittee is to establish options for a visibility standard or other method to track progress in improving visibility in the Phoenix area. The Subcommittee shall recommend the structure for a public process to determine the standard or other method. The Subcommittee shall suggest methods to evaluate the success of each control measure recommended by another Subcommittee*."

Members of the Subcommittee included Chairwoman Leandra Lewis, Vice-Chairwoman Diane McCarthy, Senator Rusty Bowers, Kevin Knight, Philip Molé, Barbara Ralston, and Mayor Skip Rimsza. Ms. Lewis and Ms. McCarthy were appointed as the Chairwoman and the Vice-Chairwoman, respectively, by Summit Chairman Ed Phillips. Members of the Subcommittee met on August 22 and 29, September 6 and 29, and October 6, 13, and 25, 2000. Minutes of the meetings were recorded by staff from the Arizona Department of Environmental Quality (ADEQ) and provided to members for their consideration. Summit members who were not appointed to the Subcommittee were welcome to participate in the deliberations. The Subcommittee did not have a quorum at these meetings, and the members present continued their deliberations as a working group. The Subcommittee was supported by work performed by ADEQ staff.

Subcommittee Working Group Meeting Summaries

August 22 - Visibility standards implemented by the states of Colorado and California, and the U.S. Environmental Protection Agency (EPA) were reviewed, detailing their structure, monitoring methods, implementation approach, and control programs.

August 29 - The importance of visual air quality to the tourism industry was discussed, focusing on how air quality affects a visitor's experience. Staff from the Maricopa Association of Governments reported on their 1999 Brown Cloud Project. ADEQ staff presented information about metropolitan Phoenix visibility data, demonstrating that higher fine particulate matter ($PM_{2.5}$) concentrations are found in the morning hours, visual air quality is much worse in the morning during the winter months than in spring and summer, and histograms of 1, 2, 4, 6, and 12-hour visibility averages illustrated an almost identical pattern. The possible form and structure of an urban visibility standard for the Phoenix metropolitan area were outlined; the standard would need to be well defined with regard to monitoring period, compliance level and form, applicable area, and measurement method. Assessment of progress in meeting the standard might be reported in numbers of "blue sky" versus "brown cloud" days.

September 6 - Another representative of the tourism industry presented their views on the Brown Cloud, and specifically how the Scottsdale Hyatt Regency deals with those concerns in their operation, by blending tourism and conservation. Staff from the EPA discussed their expectations for the Regional Haze Rule, designed to improve visibility in federal wilderness areas and national parks, called Class I Areas. Gaye Knight of the City of Phoenix presented a concept called the "Blue Sky Program" for reporting visibility data. ADEQ staff presented a possible methodology for selecting a visibility standard for the Phoenix area, which would be based upon a public survey evaluation that addresses how far and well a person can see, how visibility and health are perceived, how is progress perceived, what value does a person put on air quality and what are they willing to pay, and education of the public as to cause and effect.

September 29 - ADEQ staff presented the second and third elements of the possible recommendations which outlined the type of data collected in relation to the form and level of a proposed standard. The second element suggests using quantitative hourly data from transmissometers collected at East, Central and West Valley locations, and averaged into two, four, or six-hour blocks. The third element of the draft recommendations calls for periodic modeling analyses utilizing air pollution source emissions and air quality monitoring data. The differences between the Blue Sky goals and the scientific standard were discussed, as well as concerns about the "compliance/violation" terminology of a standard, and how public participation in selecting a standard might work.

October 6 - ADEQ staff presented definitions of the terms standard, index, and goal along with their regulatory context. After discussion, members of the subcommittee present felt that an index should be the Subcommittee's recommendation for a visibility standard. ADEQ staff also presented a possible time line for defining and implementing a visibility index and achievable interim visual range targets, as well as a draft public process time line which outlines the development of public education and valuation survey activities which lead to a visibility index. The technical aspects of tracking a visibility index were presented and discussed.

October 13 - Michael O'Neil of O'Neil Associates Marketing and Public Opinion Research spoke at length on the collection and analysis of public opinion data, and commented on his review of the study used to select the Denver visibility standard. He noted that achieving scientific certainty is a tall order and small increments of certainty are obtained at very high cost; evidence of high probability is more easily achieved. He also suggested the two objectives of public opinion sampling and education be separated because they are fundamentally different purposes and procedures. Chairwoman Lewis suggested that the public opinion sampling be done in the winter of 2001-2002. William Humble of the Arizona Department of Health Services spoke on the health aspects of the brown cloud. Health effect studies indicates that high levels of PM_{10} have been shown to increase the number of asthma, lower respiratory tract symptoms, emergency room visits, and respiratory deaths among humans. Health effect studies have also shown that $PM_{2.5}$ appears to be more damaging, due to their size. Smaller particles move more deeply into the lungs and are difficult for the body to remove; these particles are mostly composed of combustion material, which is more damaging than particles from the earth. While health effects of particles causing the Brown Cloud are well-documented, the cost to employers for absenteeism and lower productivity has not been determined for the Phoenix area; those costs could be significant.

October 25 - At Chairwoman Lewis' request, ADEQ staff presented a possible format for the Subcommittee report to the Summit. The report would include a tracking method consisting of a time line for proposed actions. The Subcommittee members present had previously recommended that the Blue Sky interim visual range targets be adopted and a public process used to determine the visibility index for the metropolitan area. The development of a visibility index could include a public survey, additional monitoring, and reporting; this process would entail a couple of years of work. Subcommittee members recommended that, in order, January and February 2002, were a good time for the public survey, then development of the monitoring, and implementation of the index. Members of the Subcommittee discussed the need to develop visibility targets beyond the 2005 time frame to evaluate voluntary control measures. Mike George of ADEQ indicated that most control strategies were scheduled for implementation in the 2003-2006 period, with some beyond this time frame; Mr. George suggested a 2003 baseline report, and then regular progress reports beginning in 2006. ADEQ staff then presented visibility data for various averaging blocks and distances that could be used to determine the averaging time, visibility distance, and number of days. The Subcommittee members present chose to focus on the 25-mile and 40-mile visual range plots in selecting the three parameters. Vice-Chairwoman McCarthy proposed a 6-hour averaging time with 25 mile visibility for 250 days in 2001, 260 days in 2002, and 275 days in 2003; the working group members agreed.

Subcommittee Working Group Recommendations

1. Select a number of days per year as interim annual "blue sky" visibility targets until a daily visibility index value is selected for the metropolitan area. The target values would be 250 days in 2001, 260 days in 2002, and 275 days in 2003.

2. Define a process to adopt a daily "blue sky" visibility index, not a standard, for the metropolitan area by the end of 2003. Significant pollution control strategies to improve visibility could be in effect by that date.

3. Require that ADEQ conduct peer-reviewed periodic scientific assessments of visibility data (2003, 2006, 2010) collected in the metropolitan area, to understand the air quality benefits of control programs recommended by the Summit. To accomplish this:

    A. Seek funding for an expanded metropolitan area visibility monitoring network, and
    B. Assign responsibility for operation of the network and the assessments to ADEQ.

The supporting information for these recommendations is presented in the following tables and figures.

Table 1. Implementation Schedule for Interim Targets and Visibility Index

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Interim Annual Visibility Targets	Identify achievable targets[1] in the Summit report	Blue Sky target value = 250 days	Blue Sky target value = 260 days	Blue Sky target value = 275 days	Blue Sky target values no longer used, metropolitan Phoenix area daily visibility index in use						
Visibility Index	Identify the process for developing the index[2] in the Summit report	Conduct public valuation survey for index level and form, purchase and install additional instrumentation			Begin additional monitoring, report daily Blue Sky visibility index values						
Periodic Visibility Assessments	Continue monitoring using a refined version of the existing visibility monitoring network to track progress; Conduct visibility assessment[3] in 2002			Prepare 2003 baseline report	Continue monitoring; Conduct visibility assessment in 2005		Prepare 2006 progress report	Continue monitoring; Conduct visibility assessment in 2009			Prepare 2010 progress report

1 = Interim targets are defined as the number of days per year when one or more 6-hour averages of daylight hours (6 A.M. to 6 P.M.) reach a visual range of 25 miles or further, calculated from visibility measurements reported by the transmissometer, until the index is adopted.

2 = The daily visibility index for the metropolitan area will have its characteristics defined through a public survey process; asking a representative cross-section of the public and visitors in the metropolitan area what visual air qualities are desirable, what visual range is acceptable, and how often the combination of acceptable visual range and air quality is preferred. The survey to develop the index value would be based upon: a) representative computer images of the Phoenix metropolitan area visual air quality; b) a clear and understandable questionnaire form to assure scientifically testable results; c) an applicable geographic area; and d) a quantitative, well-characterized measurement technique.

3 = The periodic visibility assessments will utilize air quality data from the visibility monitoring network in the metropolitan area for analysis, based on peer review, in the same manner as the baseline 1994-96 results were used for the Summit deliberations. The network and its measurement capabilities will be increased between 2001-03, pending budget approval; analytical capabilities will also be augmented as those resources become available.

Table 2 . Cost Schedule for Recommendations: Public Survey, Additional Monitoring, and Periodic Assessments

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Visibility Index ***$ 3,620,000 Overall Total***	Summit to recommend public process	Conduct public survey for index			Begin additional monitoring; report daily Blue Sky index values						
Public Survey ***$ 150,000 Total***	Prepare budget requests	Conduct survey Winter 2001-02 **$ 50,000**	Conduct public education effort **$ 50,000**		Periodic resurvey **$ 25,000 each time (2006, 2010) = $ 50,000**						
Additional Monitoring and Reporting ***$ 2,970,000 Total***	Prepare budget requests	Purchase and install instruments **$ 250,000 Startup**	Begin operations **$275,000 per year**		Continue monitoring and index measurements **$ 310,000 per year = $ 2,170,000**						
Periodic Visibility Assessments ***$ 500,000 Total***	Prepare budget requests	Based on revised monitoring plan, develop scope of work, and prepare 2003 baseline report **$ 150,000**					Prepare 2006 progress report **$ 175,000**				Prepare 2010 progress report **$ 175,000**

Dates are calendar year, budget resources would be available for the next state fiscal year (July 1 through June 30).
Costs include capital equipment, personnel, professional and outside services.
Monitoring costs include 3 fully equipped sites and technical support.

Figure 1. Distribution of 6-hour average visibility values of 25 miles or more

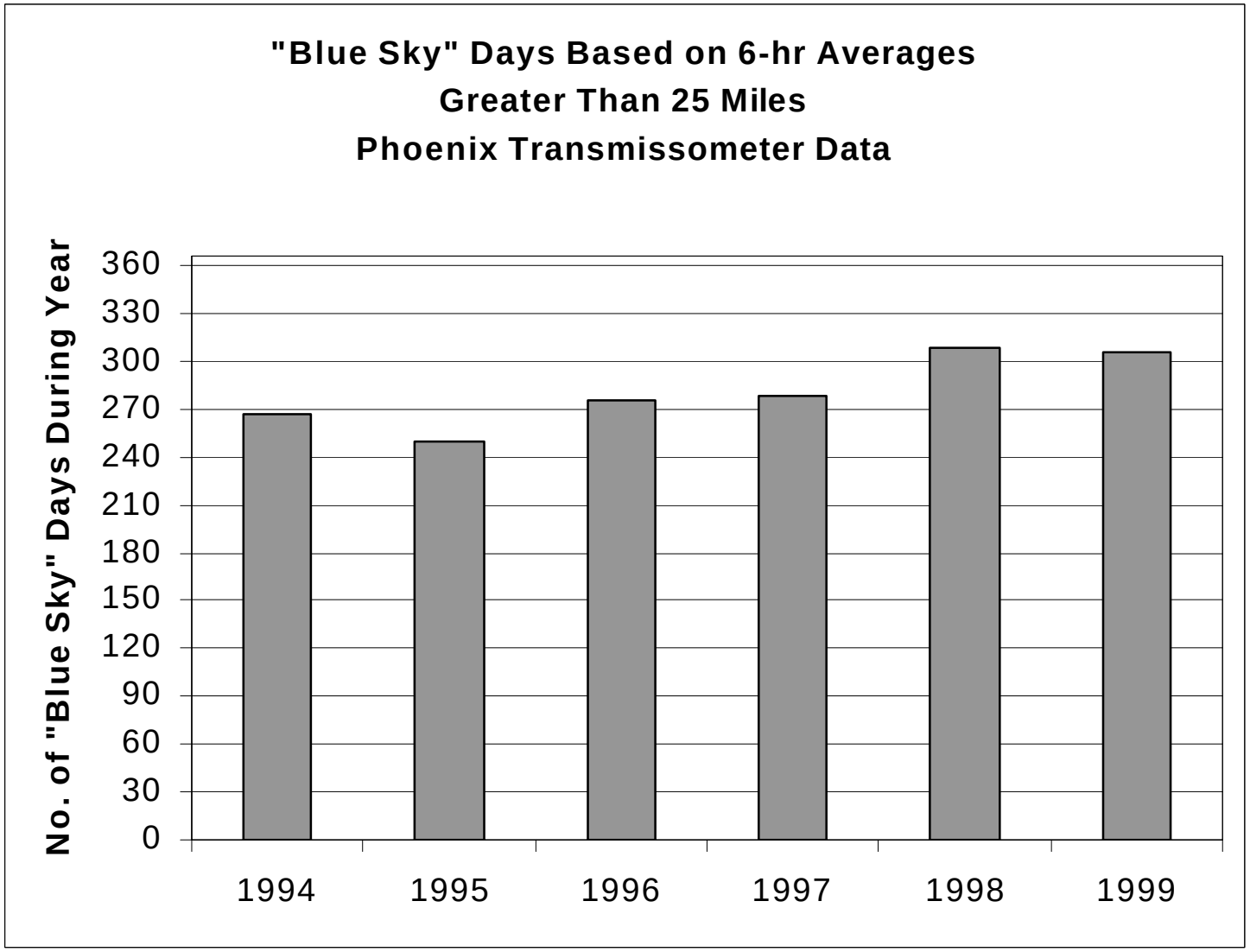

Figure 2. Average 1994-99 visibility compared to 6-hour average visibility target

20.1 deciviews (32.4 miles) versus 22.7 deciviews (25 miles)

Urban Visibility Reading List

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Note: This document contains numerous additional references.

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Glossary

Aerosol: A particle of solid or liquid matter that can remain suspended in the air because of its small size.

Ammonia: A colorless, pungent gas composed of nitrogen and hydrogen (NH_3) widely used to make fertilizers.

Area A: The part of the greater Phoenix Metropolitan area where specific pollution control programs are in place for ozone, carbon monoxide, and particulate matter. Includes parts of Yavapai and Pinal County.

California Air Resources Board (CARB): California's lead air quality agency consisting of an 11-member Governor-appointed board. It oversees county and regional air pollution management programs and manages statewide programs that regulate fuels, mobile sources.

Carbon: A naturally occurring abundant nonmetallic element that occurs in many inorganic and in all organic compounds.

Carbon monoxide (CO): A colorless, odorless, poisonous gas, produced by incomplete burning of carbon-based fuels, including gasoline, oil, and wood.

Catalyst: A substance that changes the speed of a chemical reaction without being consumed or chemically changed by the chemical reaction.

Combustion: Burning, or rapid oxidation, accompanied by release of energy in the form of heat and light.

Control measure: Equipment, processes, or actions used to reduce air pollution from stationary, area, and mobile sources.

Deciview: A measurement scale representing perceptible changes in visibility calculated from visual air quality measurement data that is gathered through air quality monitors.

Fleet: A quantity of owned or leased motor vehicles operated by a given entity.

Fossil Fuels: Substances that have formed from fossilized plants and micro-organisms, including coal, natural gas, petroleum, and fuels refined from petroleum.

Fugitive (emissions): Emissions which could not reasonably pass through a stack, chimney, vent, or other functionally equivalent opening; air pollutants emitted to the atmosphere other than from a stack.

Haze: Natural and manmade particles and gases which reduce visibility due to absorption and scattering of light. Components of haze include sulfates, nitrates, soot, unburned or partially combusted fuel, dust, and some gases.

Heavy-duty (vehicle): A truck, bus, or other vehicle manufactured primarily for use on the public streets, roads, and highways (not including any vehicle operated exclusively on a rail or rails) which has a gross weight in excess of six thousand pounds.

High Emitting (or gross polluter): Vehicles that emit twice the accepted emission standard.

Index: A ratio or other number derived from a series of observations and used as an indicator or measure of a particular attribute or phenomenon.

Light-duty (vehicle): A passenger car or passenger car derivative capable of seating 12 passengers or less.

Light Extinction: The loss of light due to scattering and absorption as it passes through the atmosphere.

Micron: A unit of length equal to one millionth of a meter (about 1/70th the width of a human hair).

Mobile Source: A source that emits air pollution while moving. Sources include: cars, trucks, buses, planes, trains, motorcycles, construction equipment, and gasoline powered lawn equipment. Mobile sources consist of two groups - on-road and off-road sources.

Monitoring: The measurement of air pollutants present in the atmosphere or emitted from a source.

Nitrogen Dioxide (NO2): A gas consisting of one nitrogen and two oxygen atoms. It absorbs blue light, resulting in a reddish-brown color and contributes directly to haze. Most emissions come from combustion of fuels in mobile and stationary sources. Some emissions come from bacterial action in soils.

Oxidation Catalyst: A air pollution control device that removes pollutants from exhaust by oxidizing them into carbon dioxide and water.

Ozone: The main component of smog. Ozone is formed through reactions among chemicals, including volatile organic compounds and oxides of nitrogen.

Particulate Matter: Solid or liquid material in the atmosphere that includes wind blown dust and soot from combustion sources. Very fine particulates, those that are under 2.5 microns in size ($PM_{2.5}$), are the most effective for causing haze.

Retrofit: Addition of a pollution control device on an existing facility, equipment or engine.

Scattering (of Light): An interaction of a light wave with an object that causes the light to be redirected.

Smog: A mixture of pollutants in the lower atmosphere, primarily ozone and ozone forming chemicals.

Standard: A quantitative value established to define compliance with the goals of protecting public health and environmental quality.

Sulfur: A naturally occurring element found in various concentrations in fossil fuels.

Sulfur Dioxide (SO2): A gas consisting of one sulfur and two oxygen atoms. Sulfur dioxide converts to a particle that is a very efficient light scatterer and contributes to the formation of haze. Primary sources of SO2 include coal and oil combustion, steel mills, refineries, pulp and paper mills, and smelters.

Temperature Inversion: A condition in the atmosphere where the temperature increases with height. Generally temperatures decrease with height, as can be seen when ascending a mountain. The presence of an inversion creates very stable layers of air. When an inversion occurs very little vertical mixing takes place, trapping pollutants near the ground.

Visibility: A measure of how far and how well an observer can see through the atmosphere**.**

Visual Range: The distance at which a dark object (e.g. a mountain) disappears from view.

VMT (vehicle miles traveled): The total number of miles traveled by all vehicles in a given area.

Volatile Organic Compounds (VOC): Compounds that contain carbon which evaporate into the air. Sources include gasoline and solvents. VOC’s contribute to the formation of smog.

GOVERNOR'S BROWN CLOUD SUMMIT

Jane Dee Hull, Governor
Ed Phillips, Chairman

RESPONSIVENESS SUMMARY
to
Comments Received on the Governor's Brown Cloud Summit Draft Report

The Governor's Brown Cloud Summit received written comments from 600 individuals during the public comment period, which began December 13, 2000, and ended January 7, 2001. Several comments resulted in revisions to the Final Report and Appendices. Such changes are identified in *italics* in the responses.

POPULATION INCREASES AND GROWTH ISSUES

Comment:
Thirty-eight comments were received suggesting that the source of the brown cloud problem is overpopulation and uncontrolled growth in the Valley. Suggestions included freezing or placing limitations on housing/apartment/business building permits and requiring impact fees or other charges to ameliorate the costs of development and growth.

Response:
There is no question that the Valley is one of the fastest growing areas of the country and this growth has been a concern for some time. Expected continued growth is one reason the Summit is recommending that two additional monitoring sites be situated in the east and west parts of the Valley to help assess the effect of growth and appropriate application of control measures. Growth does not need to be an enemy of environmental quality. In fact, if the economy doesn't grow, there are no tools in place to deal with environmental issues as they arise.

The Summit did not consider recommending measures such as freezes on building permits or impact fees.

MANDATORY VS. VOLUNTARY MEASURES

Comment:
One commenter cautioned against implementing mandates for untested and unproven programs because the costs could be disruptive for many industries and small businesses. The commenter also mentioned that such entities have worked with EPA, OSHA, CPSC, and CARB and their experiences show that voluntary standards are acceptable to sources and do encourage compliance.

A second commenter recommended focusing initially on mandatory measures to stop the "big offenders" from polluting, then focus on voluntary measures.

A third commenter suggested voluntary measures can be effective, if successfully "marketed."

Six commenters stated that experience has shown voluntary programs are, at best, marginally effective.

Response:
During their deliberations regarding potential control measures, the Summit's On-Road, Off-Road and Stationary/Area Subcommittees spent a great deal of time discussing whether specific measures should be mandated or sources be allowed to voluntarily implement. Factors such as cost, level of emission reductions, and availability of necessary technology were considered in determining whether a measure should be recommended as a mandated or voluntary program. The question of voluntary or mandatory was decided on a case-by-case basis, understanding some measures are effective on a voluntary basis and some are not.

FUGITIVE DUST SOURCES

Two commenters offered general support of fugitive dust control programs. A third commenter suggests that because this is a desert...the dust is a natural phenomenon. Specific comments included:

Comment:
One person suggested a measure be added to ban construction work on Saturday or Sunday to give the air a chance to clear out over the weekend. A second commenter suggested a moratorium on new golf courses.....and construction sites that stir and activate solid particles into the atmosphere.

Response:
Such measures were not considered by the Brown Cloud Summit.

Comment:
Two commenters suggested that mud and dirt should not be allowed to stick to tires and be brought on the public street because it causes dust. A third commenter suggested advertising the number to call and report developers who bulldoze without watering the soil.

Response:
Track-out of mud and dirt onto public streets is regulated by Maricopa County. A complaint with regard to an activity causing track-out inside Maricopa County can be filed by calling (602) 506-

6616 or visiting the Maricopa County Environmental Services Web site at www.maricopa.gov/sbeap/link-05.htm. The complaint number must also be posted at construction sites

Comment:
Three people suggested that dirt bikes and ATV's contribute to the dust emissions in parts of the Valley. One person suggested implementing and enforcing restrictions on the use of recreational off road vehicles. A fifth commenter suggests that too much emphasis is put on off-roaders.

Response:
A complaint with regard to an activity causing dust inside Maricopa County can be filed by calling (602) 506-6616 or visiting the Maricopa County Environmental Services Web site at www.maricopa.gov/sbeap/link-05.htm.

Comment:
Two commenters suggest adding vegetation in areas that do not have current day water shortages in order to reduce dust and other pollution.

Response:
Planting vegetation is one option for owners of vacant lots to reduce fugitive dust emissions; such owners must comply with local and county ordinances and regulations limiting height, etc., of vegetation used as a "dust suppressant."

Comment:
One person suggests that anti-dust regulations not lead to indiscriminate paving of open desert. A second commenter suggests voluntary dust controls of vacant, undeveloped land (not working farm land) should be addressed. There could be tax incentives for landowners who effectively address wind-blown dust mitigation.

Response:
Dust control regulations generally apply to active areas, such as construction sites, rather that open desert.

Comment:
Five commenters suggest paving unpaved roadways as a means to reduce dust.

Response:
The Maricopa Association of Governments (MAG) serious area PM10 Plan for the Maricopa County non-attainment area includes commitments from Maricopa County and MAG members to address unpaved roadways. As an example, Maricopa County plans to pave 60 miles of heavily traveled unpaved roads in it's jurisdiction.

Comment:
Twelve comments were received suggesting Maricopa County should increase enforcement and inspections for Rule 310. Another person suggested adding weekend inspections for construction sites.

Response:
Rule 310 is Maricopa County’s rule to control fugitive dust sources. A companion rule, Rule

310.01, regulates fugitive dust from open areas, vacant lots, unpaved parking lots, and unpaved roadways. Although PM2.5 is the particulate pollutant of concern for visibility, the rules are an important component in controlling all particulate matter emissions in the Valley. Maricopa County Environmental Services Department has worked closely with EPA to enhance the County's existing enforcement policy and procedures as related to inspection and enforcement actions for fugitive dust sources. Copies of the rules and policy are available at www.maricopa.gov. One of the Summit's suggested measures is to increase funding to provide additional inspectors for both Maricopa and Pinal Counties and enhance existing inspector training.

Comment:
One commenter suggests commercial, state, city, etc, control "dust sites" until construction is complete and suggests dust fines.

Response:
Maricopa County Rule 310, which addresses construction and other dust sources, applies to all phases of construction and provides for the County to impose fines for non-compliance.

Comment:
One person stated that the waste management landfill and Indian industrial park in southeast valley creates dust which contributes to brown cloud. And another person stated there is dust and odor near 107th Ave and Baseline from a feed lot and dust from unpaved road.

Response:
Please direct concerns with respect to a specific pollution source to Maricopa County Environmental Services at (602) 506-6616 or the Maricopa County Environmental Services Web site at www.maricopa.gov/sbeap/link-05.htm.

Comment:
One person asked if the following statement on page 4 was a typo "Dust, principally from driving on roads.."

Response:
The statement is not a typo. It refers to dust (particulate matter) emissions generated from the action of automobiles being driven on paved roads. Particulate matter on paved roadways exists in several forms, such as rubber tire particles, brake material, crustal material (soil) tracked or spilled on the roadway, and crustal material deposited on the roadway from winds.

The 1994 emissions inventory for fine particulates, published in the Maricopa Association of Governments PM10 Plan (1999), shows that dust from paved roads is the highest source category of fine particulates. The categories and their percent contributions are as follows:

paved road dust	35%
fossil fuel combustion (cars, trucks, heavy equipment boilers, industrial)	25%
agricultural and construction dust	23%
unpaved road dust	14%
fires, meat cooking	3%

The paved road emissions come from both exhaust and soil particles that are deposited onto the roadways and are re-suspended by moving traffic. As the dirt roads in the metropolitan area have been paved, and some aggressive paving programs are underway by Maricopa County and several cities, the unpaved road dust portion of the inventory will shrink. As the vehicle miles traveled continues to grow – it is now about 67 million miles per day – the paved road dust portion will grow. This source of fine particulates, whose reduction is accomplished by better and more frequent street sweeping, will continue to pose a problem well into the future.

ALTERNATIVE FUELS

Comment:
One commenter said Maricopa County should be required to implement a program to replace existing vehicles with alternative fuel vehicles.

Response:
Arizona Revised Statutes, Section 49-474.01, requires Maricopa County to implement a vehicle fleet plan to encourage and increase the use of alternative fuels in county owned vehicles operating in Area A. Several factors are involved in establishing an alt fuels program, including available funds for converting or purchasing vehicles and installing alt fueling stations. In early 2000, the County received a grant for a propane vehicle project. This will provide for 82 vehicles to be operated on propane. In addition, Maricopa County has 10 vehicles operating on compressed natural gas and 12 operating on methanol. (See Final Report - Maricopa County Propane Vehicle Project, December 21, 2000).

Comment:
Twenty-one comments were received suggesting that alternative fuel vehicles and fueling stations be promoted.

Response:
Arizona Revised Statutes, Section 49-474.01, requires Maricopa County to implement a vehicle fleet plan to encourage and increase the use of alternative fuels in county owned vehicles operating in Area A. All other government fleets are making progress toward similar goals. Additional incentives for private investment in alternative fuels also exist.

Comment:
One commenter was concerned about the infrastructure required to provide alternative fuel.

Response:
An infrastructure is being developed to provide alternative fuel. Infrastructure will be expanded as demand for alternative fuel increases.

Comment:
One commenter suggested increasing alternative fuel vehicles to 100% by 2010.

Response:
This is a good suggestion but may not be practical, as it creates a dependency on a single resource

for transportation fuels.

Comment:
Five comments were received suggesting that hydrogen fuel be promoted. Two commenters suggested that alcohol fuel be promoted. Thirteen comments were received suggesting that electric and hybrid vehicles be promoted.

Response:
Delivery and storage problems would need to be resolved before hydrogen fuel use could become widespread. For these reasons, such a measure was not considered by the Summit. Alcohol-based fuels are already in use, so the measure was not considered by the Summit. Electric and hybrids are now available and relatively attractive because of their costs of operation are lower than conventionally fueled vehicles. As the technology improves and the premium that buyers currently pay to acquire these vehicles goes down, they will, naturally, become a larger proportion of the vehicle fleet.

Comment:
Seven comments were received suggesting that public and school buses be converted to electric or LPG.

Response:
Some public and school buses have already been converted to LPG and more are scheduled for conversion. Most, if not all of the transit buses currently being purchased are either CNG or LPG fueled.

Comment:
One commenter suggested that affordable low polluting city vehicles be promoted, e.g., golf cart type vehicle.

Response:
Neighborhood electric vehicles that are street-legal are already available on the open market and are increasing in popularity.

Comment:
One commenter suggested that support for/promote solar vehicles be increased.

Response:
As the technology for solar vehicles is in its infancy, such a measure was not considered by the Summit.

Comment:
One commenter suggested that a new alternative fuel that relies on a chemical process different from current combustion process be promoted.

Response:
As no details were provided regarding this technology, it is not possible to evaluate it as a potential control measure for consideration by the Summit.

TOURISM

Comment:
One commenter suggested the State stop promoting tourism during the winter.

Response:
The Summit's charge from Governor Hull in Executive Order 2000-3 was to identify and consider strategies that were previously recommended but not implemented or considered, but not recommended, by the 1998 Governor's Air Qualities Strategies Task Force, and measures to improve visibility that are either under consideration or implemented by other states. Although halting the promotion of tourism was not a measure considered by the Task Force or any state reviewed by the Summit, the Visibility Standards Subcommittee did hear presentations regarding the importance of air quality to the tourism industry. Tourism representatives expressed concern that continued worsening of the area's visibility would have a negative effect on the number of visitors.

CONSTRUCTION INDUSTRY

Comment:
One commenter expressed concern that the construction industry would "knock down" a large portion of the measures because of the impact on that sector.

Response:
The construction industry has actively participated in the Summit, particularly as a member of the Off-road Subcommittee. While the Summit cannot assure that any recommendation will be implemented as submitted to Governor Hull, the draft report did move to the public review and comment period by an overwhelming vote of Summit members. Hopefully, such support will continue as the Legislature and Governor take further action.

Comment:
Two commenters mentioned that the very dirty, black-belching diesel from construction equipment highlights the need for emission standards.

Response:
The federal Clean Air Act precludes individual states from adopting regulations governing emissions from new heavy-duty nonroad engines[1]. In addition, a federal court decision (Engine Manufacturers Association v. EPA) held that the preemption extends to both new and in-use engines, preventing states from requiring retrofitting of used nonroad engines. As a result, the Brown Cloud Summit recommends several voluntary control measures which encourage retrofit or early replacement of old nonroad diesel equipment and diesel vehicles.

The U.S. Environmental Protection Agency (EPA) has established emission standards for several

[1] "Nonroad" or "off-road" is a term that covers a diverse collection of engines, equipment and vehicles, and includes construction and farm machinery, outdoor power equipment, recreational vehicles, lawn and garden equipment, locomotives, aircraft, and many other applications.

nonroad engine categories. Until the mid-1990's, very few of these engines faced any kind of emission standards. The first federal standard (Tier 1) for nonroad (or off-road) diesel engines was adopted in 1994 for engines over 50 hp to be phased in from 1996 to 2000. The standard covers mobile nonroad diesel engines of all sizes used in a wide range of construction, agricultural, and industrial equipment. Examples of regulated applications include farm tractors, excavators, diesel lawn tractors, bulldozers, portable generators, road graders, and large forklifts. The regulations are structured as a 3-tiered progression to low emission standards. Each tier involves a phase in (by horsepower rating) over several years. Tier 1 standards are phased in from 1996 to 2000. A more stringent Tier 2 standard for all engine sizes takes effect from 2001 to 2006, and yet more stringent Tier 3 standards are phased-in from 2006 to 2008. The Tier 3 standards are expected to lead to emission control technologies similar to those that will be used by manufacturers of highway heavy-duty engines to comply with the 2004 highway engine standards.

MEMBERSHIP

Comment:
One commenter criticized the fact that the membership of the Summit did not include neighborhood groups or relevant environmental organizations.

Response:
The members of the Summit were selected by Governor Hull in an effort to represent the broad spectrum of interests in the Phoenix area. Representatives include the cities, health organizations, and environmental groups.

Comment:
Do you think that having an individual on the committee who owns a trucking fleet might not be a conflict of interest?

Response:
If only trucking industry representatives were members of the Summit, that might be the case. The Governor selected the Brown Cloud Summit members as representing public, private and citizens groups that were willing to participate in a stakeholder process to reduce pollution, improve visibility, and protect the public health from the effects of the brown cloud. The Summit was charged with soliciting and receiving comments from citizens, governmental agencies and other affected parties. This was done by adhering to the public meeting laws, announcing the agenda to the public, providing minutes information both via Internet and having documents available for public review. Every Summit meeting and Subcommittee meeting was open to the public.

Comment:
I would like to know how I could get on this board (BCS) or help out with some of my own ideas or comment on your ideas.

Response:
The Governor selected the Brown Cloud Summit members as representing public, private and citizens groups that were willing to participate in a stakeholder process to reduce pollution, improve visibility, and protect the public health from the effects of the brown cloud. The tenure of the Brown Cloud Summit is almost finished with recommendations to the Legislature for reducing the

brown cloud due this Legislative session.

LEGISLATIVE ACTIONS

Comment:
Two commenters suggested that all legislative votes taken on the recommended measures be made public in the Arizona Republic or other media channels.

Response:
Media content is determined by the individual newspaper, TV or radio station. Legislative sessions are open to the public and voting results are available to the public. More information regarding the legislative process is available at www.azleg.state.az.us.

REGULATORY PROGRAMS

Comment:
One commenter inquired about traditional regulatory programs.

Response:
Traditional regulatory programs are often referred to as "command and control" programs. Such programs usually consist of laws and/or rules requiring affected sources to do something with little flexibility in how or what to do.

BROWN CLOUD SOURCES

Comment:
One commenter mentioned that the report does not clearly state what the makeup of pollution is and the sources of that pollution.

Response:
The intent of the report was to provide a more general, layperson's view of what the contributors to visibility impairment are. The attachments, in particular Appendix 4, are intended to provide a more detailed, technical discussion of this question.

Comment:
One commenter mentioned that buses, planes, diesels, etc., are the biggest polluters, not lawn mowers and leaf blowers.

Response:
The report states on page 3 that "Over half of the PM2.5 is caused by the burning of gasoline and diesel fuel in vehicles (which are sometimes referred to as on-road mobile sources) and in off-road mobile sources, such as construction equipment like loaders and bulldozers, locomotives, lawn

mowers, leaf blowers and other devices that emit air pollution as they move."[2] Of the 19 control measures the Summit recommends, 10 specifically address diesel exhaust. For information regarding the Summit's recommendations on aircraft, see the Aircraft/Ground Support Equipment section of this responsiveness summary.

Comment:
One commenter stated that the documented source of pollution is industry, causing up to 70% (per unidentified reports published by the state).

Response:
As documented in Appendix 3 of the draft report, industry causes between 3 and 5 % of the Brown Cloud on the worst days.

Comment:
One commenter stated they have not found anything on this site concerning mitigation of the Urban Heat Island (UHI) effect and asked what ADEQ is doing to promote mitigation of the UHI effect?

Response:
The primary charge of the Brown Cloud Summit is to deal with visible pollution. The Summit did not specifically consider measures to reduce the urban heat island effect; although pollution reduction programs identified by the Summit may assist in mitigating the effect.

Comment:
Two commenters inquired about cigarette and cigar smoke and its impact on the brown cloud. One commenter inquired about a machine to create rain (although it would not be good for the plants for all that garbage to fall down on us, at least we would breathe a little easier, for a while).

Response:
The analyses used to determine the causes of the Brown Cloud did not specifically examine how much is caused by tobacco smoke. The questions of where and how cigarette smoking should be regulated is by local ordinance.

Comment:
One person stated they are more concerned with the true quality of the air vs. its visual appearance. The commenter also stated that while diesel burning engines do contribute more particulates to the air they emit much less of the dangerous pollutants and the new diesel motors emit much less of the particulates. The commenter also suggests because of the alternative fuel debacle, this legislature is going to have a tough time pushing more costs on to the public in the form of brown cloud reduction efforts and suggests a retreat for a year or two and develop some sensible solutions that don't cost the public even more money.

Response:
Newer diesel engines are cleaner than older diesel engines, in terms of visible and invisible pollutants. While in the past diesel engines were cleaner than gasoline engines for invisible gaseous

[2]Appendix 3, Sources of Fall and Winter Visibility Impairment in Phoenix, page 5-2.

pollutants, automobile gasoline engines are now much cleaner than diesel engines for both visible and invisible pollutants.

Comment:
One commenter asked does this include fugitive gas particles as well as various sources of VOCs?

Another commenter stated while the report contains some valuable information, it fails to follow a logical path to recommendations. This could be simplified for communication in another way such as (1) a Pareto chart of the top 20 things that cause the brown cloud? (carbon, dust, etc.) followed by (2) for each of those items, what are the primary contributors? (also in Pareto chart format). This would show, in simple form, what the cloud is made of, and what the things are that make "those elements found in the cloud." The commenter also suggests clearly ranking the top contributors, then show examples of approaches other cities have used to mitigate these core contributing factors...then extrapolate the difference these improvements could make on the overall brown cloud. And choose solutions only after completing these correlations.

Response:
In Appendix 3 of the draft Report, an ADEQ contractor analyzed the causes of the Brown Cloud, showing the percentage contributions of the atmospheric constituents (carbon, dust, etc) and the associated source categories (on-road vehicles, non-road vehicles, wood burning, etc). This analysis started with the pollution sampling information, which accurately describes what was in the air, moves to the broad source categories defined by chemical fingerprints, and then resolves individual fuel combustion source categories using the detailed emissions inventory for the Phoenix metropolitan area. Gaseous compounds were not considered as part of this analysis; future analyses may need to address that question.

HEALTH

Comment:
The Summit received twelve written comments regarding the impact of air pollutants on their health or the health of their family.

Response:
PM2.5, the prime cause of poor visibility in the Valley, also causes health effects such as asthma attacks and other heart and lung problems. Reductions in emissions that result in improvements in visibility will also improve public health.

Comment:
One person asked who is Dr. Pope and how did he come to the conclusion between 250 and 1000 additional deaths per year are attributable to the brown cloud?

Comment:
1. Page 4, "Health Effects" paragraph: The health effects noted in this paragraph are attributed via footnote to Dr. C. Arden Pope, Professor at Brigham Young University, at the Brown Cloud Summit meeting of July 11, 2000. The minutes of that meeting do not substantiate some of the statements made in the Draft Report.

To wit: The Draft Report says "$PM_{2.5}$, ... also causes health effects such as asthma attacks and other heart and lung problems that cause people to need to go to hospitals, and is consistently associated with higher than average death rates."

It is reported in the minutes of the July 11, 2000 Brown Cloud Summit meeting that "Dr. Pope outlined a brief history of the different techniques used to correlate health effects to air pollution. Dr. Pope's research indicates that a 1.5% increase in mortality occurs for every 10 micrograms per cubic meter increase in air pollution. More sophisticated studies have found a 15-17% increase in the likelihood of mortality attributable to air pollution in high pollution cities compared to low pollution cities. Dr. Pope also discussed studies which demonstrated that respiratory illness was exacerbated by elevated concentrations of fine particulates. He pointed out emerging information that elevated concentrations were also associated with cardiopulmonary illness."

It was also reported in the July 11 meeting minutes that "Another member asked whether asthma increased as a result of pollution. Dr. Pope responded that particles in air pollution exacerbate asthma conditions but that he did not know if asthma is caused by air pollution."

These meeting minutes are quite different than what is reported in the Draft Report and attributed to the July 11 meeting and Dr. Pope!

2. The last sentence of the "Health Effects" paragraph in the draft Report states that "Applying the results of recent health studies to $PM_{2.5}$ levels measured in the Valley, between 250 and 1,000 additional deaths in the Phoenix area each year are currently caused by $PM_{2.5}$ air pollution."

The only statement that comes close in the July 11 meeting minutes is as follows: "One member also commented that about 125,000 deaths per year in the U.S. are a result of diesel exhaust and that about fifteen hundred deaths per year in Phoenix were related to air pollution. Dr. Pope thought that most of these deaths were attributable to small particulates, ..."

It is suggested that statistics quoted should be traceable to a peer reviewed article, magazine report, or book. The credibility of the entire report is suspect if any data cannot be traced back to a peer reviewed source.

Response:
Thank you for your notation of our quotation and attribution errors. Research studies by Dr. Pope and others show that elevated $PM_{2.5}$ air pollution levels exacerbate the numbers of asthma attacks and cardiopulmonary illnesses, and are consistently associated with higher than average death rates. *The text will be corrected in the final report to accurately reflect Dr. Pope's July 11 presentation.* Also, the "... between 250 and 1,000 additional deaths ..." statement was incorrectly attributed to the July 11 presentation by Dr. Pope. He made that statement in a personal communication to ADEQ staff on August 30, 2000. *The footnote for this statement will also be changed in the final report.* A recent complete source is Air Pollution and Health; edited by Holgate, S.T., Samet, J.M., Koren, H.S., and Maynard, R.L.; Academic Press, San Diego, CA; 1999. Dr. Pope co-authored Chapter 31 of that book, entitled: Epidemiology of Particle Health Effects.

Comment:
As a native of Arizona, I believe this is a great beginning and I applaud the committees efforts and recommendations. I have been told that the other real health hazards to poor air quality also comes

from the pollution that is not visible. If this is true I believe this fact should be stressed.

Response:
The primary charge of the Brown Cloud Summit is to deal with visible pollution. Invisible air pollutants are also measured and controlled across the state, and the health effects of those pollutants are reflected in their health standards.

HEALTH VS. COST

Comment:
The reader cannot tell by reading the report if adequate weight was given to public health and quality-of-life issues, vs. cost for the trucking and construction industries.

Response:
In the initial work of the various subcommittees, a variety of criteria including other environmental effects (e.g. health effects), were used in honing in on a few key approaches from a much longer list of candidate control measures. Later in the process visibility improvement was assessed on equal footing with cost effectiveness, and improving visibility certainly has direct benefits to quality-of-life and indirect effects on human health through reducing particulate pollution.

COST VS. BENEFIT

Comment:
Two commenters questioned whether the numbers used were measured scientifically or estimates (or both)?

Response:
A combination of measurements and estimates were used. Where available, real data were utilized. For example, most of the pollution control technology has known costs per unit, based on information gathered from manufacturers and measured by individual unit emission reductions, based on testing by a variety of entities which have been researched through literature and used in the technical analyses. Since many kinds of sources are not required to be licensed, thus an actual population is not known. The total number of sources (e.g. pieces of construction equipment) to multiply against the per unit costs and benefits to get total visibility improvement and cost in the Phoenix area must then be estimated.

EFFECT OF INVISIBLE EMISSIONS

Comment:
The commenter states the various aspects of the report are potentially helpful in reduction and/or control of anthropomorphic emissions, but the bulk of the study appears to be focused on visible particulates. What are the links to invisible emissions. Aren’t these also important?

Response:
The primary charge of the Brown Cloud Summit is to deal with visible pollution. It should be noted

that not all visible pollutants are particulate, and not all particles are emitted directly as visible particulate. Nitrogen dioxide is a gas that absorbs light, appearing brownish in color, and was a significant consideration in this process. Also, particles form in the atmosphere through chemical reactions of gaseous compounds. For example, almost all solid ammonium sulfate that is suspended in the atmosphere started out as sulfur dioxide gas and gaseous ammonia (among other things). Finally, the Summit also considered other air quality effects, like effects on ozone levels, in its initial screening process, trying to identify control measures that have multiple benefits.

CONTROL MEASURES IMPLEMENTATION

Comment:
One commenter stated that the time frame included in the draft report looks like a decent start but is way too long. The effectiveness will be reduced over time due to many factors not the least of which is the growth of Phoenix. To have a meaningful effect for those of us living here now, your 20 year time frame needs to be cut in half.

A second commenter stated that drastic changes need to take place now to improve the air quality. By 2020, many of us may not be here to enjoy the improvement. By then the measures instituted may not be stringent enough to have the kind of impact expected. Time frames need to be moved up dramatically so the air can be cleaned up now.

Response:
Actually, the measures were assessed for a variety of time frames between the present and the year 2020 (i.e. 2003, 2006, 2010, and 2015). The year 2020 was chosen for comparing measures since it would take that long for some of the recommended strategies to become fully effective. In other words, even if a program was started in the next few years, it might take several more for its full effect to be known. The specific measures included in the report are recommended to start up as soon as is practicable, generally by the year 2004. It sometimes takes up to three years to get a strategy implemented with the legislative and regulatory processes that must occur beforehand.

AIRCRAFT/GROUND SUPPORT EQUIPMENT (GSE)

Comment:
Nineteen comments were received suggesting that the report should provide more focus on aircraft as a large contributor to the brown cloud. Some stated the significant increase in airline traffic through Sky Harbor International in the past few years is contributing significantly to the pollution in the Valley. Statements were made that 40 to 85 percent of the total pollution in the Valley is a direct result of the emissions generated by these aircraft. One suggestion was that if planes could somehow limit or filter their exhaust systems the air quality in Phoenix would improve.

Others suggested the Summit consider an airport bypass and relocating the airport. Locations suggested were south of Coolidge and south of the Casa Grande area, with a rail system that comes from Phoenix and Tucson.

Two commenters mentioned the Ground Support Equipment control measure (#8). One felt it should be mandatory, not voluntary, the second suggested some type of tax incentive or funding to

support the effort. Another commenter inquired how businesses might be encouraged to voluntarily replace their GSE.

Response:
Detailed discussions were held by the Off-road Subcommittee regarding the impact of the three types of emissions from airports - vehicular traffic, ground support equipment, and aircraft exhaust. The Subcommittee discovered that while the emissions from aircraft at Sky Harbor are by no means insignificant, the fine particulate emissions from aircraft exhaust contribute about 0.9% (539 kg/day) to the metropolitan total emissions (58,150 kg/day). The following table from the Maricopa Association of Governments particulates emission inventory, and work done by Arizona Department of Environmental Quality, summarizes the emissions from the three categories.

SOURCE	EMISSIONS IN KILOGRAMS /DAY	% METROPOLITAN TOTAL EMISSIONS
airport ground support	627	1.1
aircraft exhaust	539	0.9
vehicular traffic	352	0.3

Section 233 of the federal Clean Air Act mandates that aircraft engine emissions standards be set only on a national level. Emission standards for gas turbine engines that power civil aircraft have been in place for about 20 years. Such engines are used in virtually all commercial aircraft, including both passenger and freight airlines. The standards do not apply to military or general aviation aircraft, but included in the report is a Summit recommendation that the Arizona Legislature pass a resolution urging EPA to adopt emissions standards for commercial and National Guard aircraft.

The Summit is also recommending a program for airport ground support equipment (GSE), which includes the various tractors and haulers that operate on the tarmac. The suggested measure is to convert equipment from diesel-powered to electrical-powered vehicles by 2005. Because GSE is owned by the airlines and not the airport, the Subcommittee decided more could be accomplished by initiating efforts with individual airlines in the near term, rather than having to promulgate regulations before a mandated program could be initiated. During the Subcommittee meetings, airline representatives did indicate a willingness to meet the goals of the proposed measure.

Removing the airport entirely from the Salt River Valley would eliminate about 2% of the fine particulate pollution. Because the airport is centrally located, the overall vehicle mileage for airport-related trips is less than it would be for a peripheral location. This overall reduction in mileage translates into fewer air pollutant emissions being generated within the metropolitan area.

Comment:
Appendix 1, Page 31: One commenter asked why the tables have no capital cost and suggested that the cost of equipment would be quite substantial for fleet owners.

Response:
The voluntary replacement of airport ground support equipment control measure assumes an 18 percent conversion by 2003 and full conversion (30 percent) by 2005. The ITAG assessment tool does not allow for costs to be input in 2005, therefore the capital costs were input for 2003 and 2006 and are reflected in the table.

Comment:
Appendix 1, Page 33. One commenter suggested that the emission reductions appear to be over estimated by 90 percent. The commenter stated that the airlines both testified that the emission reductions are being sold to local electrical utility companies and therefore 90 percent of the emissions will remain in the air shed.

Response:
The voluntary replacement of airport ground support equipment control measure assumes the 30% replacement of GSE is over and above any conversions completed as a result of regulatory requirements.

CLEAN FLEET AND EQUIPMENT PROGRAM

Comment:
Two comments were received regarding this recommendation. One person stated that rather than requiring 51% of vehicles conform to minimum standards it should be mandatory for 100% of vehicles. The second commenter suggested the program apply to agricultural farms and businesses as well.

Response:
This measure is intended to encourage replacement of heavy-duty diesel equipment and vehicles manufactured prior to EPA's Tier 2 diesel emission standards for new off-road equipment and EPA's model year 2004 diesel standards for new on-road vehicles. In other words, this measure encourages businesses to retrofit, replace, or convert their older, dirtier heavy-duty diesel equipment and vehicles. *This point was not clearly stated in the Summit report and will be clarified in the final report.*

This measure applies to any business that owns or operates heavy-duty diesel equipment and vehicles (100 horsepower or greater) and that bids on state and local government contracts. At its November 28, 2000, meeting, the Summit agreed that on-road equipment used for contracts would also be considered. *The Final Report will be revised to reflect the inclusion of on-road equipment.*

Comment:
One commenter suggested requiring that all contractors who wish to bid on a municipal project be required to meet a minimum standard of compliance by a certain date. The following example was provided: after 2004 all bidders must be at 33% compliance before a bid will be considered. Those who meet 51% compliance and above will be given priority with those nearest 100% compliance given the most "points".

Response:
The Off-Road Mobile Controls Subcommittee initially considered a mandatory program but later

decided that requiring all businesses to retrofit their equipment/vehicles in order to contract with government entities may discriminate against some businesses. The measure was revised to encourage businesses to retrofit, replace, or convert their older, dirtier heavy-duty diesel equipment and vehicles by awarding "extra" points in state and local government bidding processes. Legislation will be necessary to authorize awarding "extra points" to qualifying businesses. The intent of the report was to provide a conceptual description of the measure. The specific point system will be established during the legislative process or during program development.

AIR QUALITY ALERT DAYS

There was one general comment in support of the Air Quality Alert Days measure. Specific comments and responses follow.

Comment:
One commenter suggested that visibility pollutants continue to increase as more of the agriculture land is converted to pavement. If this is only an alert, that's OK, but not if the intent is to consider dust a pollutant. Another commenter suggested that instead of calling bad air days "Air Quality Alert Days" they should be called "Poor-Vis Days"?

Response:
The Air Quality Alert Days measure is not intended to address only poor visibility days or dust, but also considers pollutants such as carbon monoxide and nitrogen oxides.

Comment:
One commenter suggests that TV weather people should not say "it's okay to burn".

Response:
Advisories made to the public generally indicated that fireplace use is "permitted" or "not permitted" on a particular day, based upon pollutant levels and weather forecasts. Because program scheduling, etc., is decided by individual media outlets, how television stations choose to state the status of fireplace burning was not addressed by the Brown Cloud Summit.

Comment:
One commenter does not believe that requiring private citizens to lower their use of motor vehicles on air quality alert days will be effective until sufficient alternate means of transportation are provided.

Response:
Statistics collected by Westgroup Research indicates that 3.5% of people change their mode of transportation when air quality alerts are called. Benefits can be gained through existing transportation systems, alternate work schedules, and telecommuting opportunities offered by employers.

Comment:
One person suggests restrictions on vehicles idling in drive thru windows on alert days.

Response:
Thank you for your suggestion, which will be represented in the Final Report.

Comment:
One person stated the control measure seems to provide an insignificant return and is very expensive and suggests the Summit revisit the measure in order to best utilize funds.

Response:
This measure simply adds onto an existing system. While we don't expect large reductions, it is one of the few measures that has a public campaign to educate citizens of the actions they can take to improve air quality.

Comment:
People should carpool and should not have fires in their fireplaces on days with bad air.

Response:
Emission reducing activities such as carpooling and restrictions of fireplace use are currently done through the summertime ozone advisory and wintertime pollution advisory programs. The Air Quality Alert Days program has been proposed to replace the wintertime pollution advisory program and will include emission reducing programs such as carpooling and fireplace use restrictions.

BAN LEAF BLOWERS

At least 45 people voiced opposition to a ban on the use of leaf blowers for a variety of reasons including; increased cost to businesses, loss of employment, belief that a ban on leaf blowers would not improve the brown cloud, the measure is not enforceable, water must be used in place of leaf blowers, and belief that other sources of pollution have a greater contribution to the brown cloud. Conversely, approximately 50 people stated that they support a ban on the use of leaf blowers for a variety of reasons including; odor of exhaust emissions, potential health impacts such as asthma and allergies, the impracticability and inefficiency of leaf blowers, and blowing of material into streets. In addition, specific comments were received and are responded to as follows.

Comment:
Several commenters suggested that if leaf blowers are banned, owners of the equipment receive some type of rebate, incentive, or reimbursement for the loss. Others suggested developing programs to encourage and support, through financial or other means, use and conversion to electric blowers and other yard equipment.

Response:
Neither the Summit nor the Stationary and Area Source Subcommittee addressed this possibility in their deliberations. It is noted that Maricopa County has operated a program to replace older gas lawn and garden equipment with electric equipment by providing vouchers towards the purchase of electric equipment when owners turn in gasoline operated equipment.

Comment:
Three people suggested use of electric leaf vacuums rather than leaf blowers.

Response:
Electric leaf vacuums were not evaluated by the Brown Cloud Summit, but could offer pollutant reduction as compared to gas powered leaf blowers. The recommended measure does not restrict the use of alternate methods or equipment.

Comment:
Two commenters mentioned that it wasn't that clear that the ban on leaf blowers is for gas blowers only.

Response:
Because fugitive dust comprises a large portion of the emissions from leaf blowers, the measure as described and evaluated by the Summit includes a ban on both gas and electric leaf blowers. *The report will be revised to clarify the extent of the proposed ban.*

Comment:
One person suggested restricting leaf blowers from properties of one acre or less as mandatory and all other areas as recommended.

Response:
This type of operational restrictions could also provide emission reductions, but would likely reduce pollution less than would the proposed ban.

Comment:
One person suggested one of the greatest challenges is the commercial lawn care companies' equipment. One step could be to give contracts to companies that use electric equipment for all government building locations.

Response:
Such a contract requirement was not considered by the Summit. Many municipalities in the Phoenix area, however, have voluntarily implemented programs to replace gas blowers with electric and restrict time-of-day use of leaf blowers.

Comment:
A commenter indicated that the ban on leaf blowers should be limited to homeowners who would only be allowed to use electric blowers. A second commenter suggested homeowners be allowed to use gas powered leaf blowers.

Response:
As the comments indicate, there are varying views regarding the extent to which this measure should be implemented. Limiting a ban to only homeowners would provide emission reductions, but obviously to a lesser degree.

Comment:
Two commenters suggested requiring commercial property and new homes to be xeroscaped with no lawns, thereby, eliminating the use of leaf blowers and lawnmowers and reduce water use.

Response:
Although it does reduce the need for water and mowing, xeroscaped landscapes may contain leafy

vegetation in one form or another that would need to be removed.

Comment:
One person inquired where one can find data on the estimated annual cost and annual benefits of 2-cycled powered leaf blowers.

Response:
The Sierra Research 1997 study referenced in the Maricopa Association of Governments, "Particulate Control Measure Feasibility Study, Vol. II" included the following analysis:

Equipment/Operational Cost

Purchase cost of leaf vacuum - $275 (vendor data)
Useful life - 3 yr (commercial service)
Capital recovery factor - 0.402 Annualized cost $111/vacuum-yr
Annual daily use - 2 hr/day (estimated commercial use)
Annual use rate - 500 hr/yr (estimated commercial use) 250 days/yr
Annual maintenance cost - $135/vacuum-yr (estimate)
Total annual equipment cost - $111/vacuum-yr
Total daily cost - $0.44/vacuum-operating day

There is no known scientific study on the annual benefits to the public of powered leaf blowers. There are several anecdotal stories published in local newspapers both supporting the use of leaf blowers and against leaf blowers.

The Portable Power Equipment Manufacturers Association (PPEMA) represents the world's leading manufacturers of handheld outdoor power equipment has reported the following national sales projections for handheld blowers and backpack blowers.

Handheld Blowers
During 1998, industry shipments of gasoline-powered handheld blowers increased by more than 30% to 1,614,760 units. During 1999, industry shipments of gasoline-powered handheld blowers increased by 2% to 1,647,850 units. It is estimated that industry shipments for 2000 will increase by 5%.

Backpack Blowers
During 1998, industry shipments of gasoline-powered backpack blowers also increased by more than 30% to 253,400 units. It is estimated that industry shipments for 1999 increased 4%. During 1999, industry shipments of gasoline-powered backpack blowers increased by 15% to 290,230 units. It is estimated that industry shipments for 2000 will increase by 10%.

Comment:
One person suggested including gas powered edgers and weedeaters in the ban. Also, possibly start a program where people who turn in their gas powered blowers, weedeaters, and lawnmowers would get credit on the purchase of electric mowers, etc.

Response:
Maricopa County has operated a voluntary lawn and garden equipment buyback program since 1997. The program allows commercial and residential owners to obtain vouchers towards the

purchase of electric equipment when retiring gas-powered equipment. The Legislature has funded the program through June 2001 for $400,000. These funds were expended by August 2000, which resulted in the retirement of 2574 lawnmowers and 542 pieces of handheld lawn and garden equipment.

Comment:
The commenter asked how much pollution is really going to be reduced by banning leaf blowers.

Response:
Page 4 of the Stationary and Area Source Subcommittee report to the Brown Cloud Summit (December 8, 2000), banning leaf blowers would result in estimated reductions in the combustion of fuels of 1.31 ton per day (tpd) hydrocarbons, 0.004 tpd NOx, 0.0155 tpd $PM_{2.5}$, 3.83 tpd carbon monoxide, and 0.0006 tpd PM_{10}. Fugitive particulate emission reductions were estimated to be 4.6 tpd of PM_{10} and 2.18 tpd of $PM_{2.5}$.

Comment:
The Brown Cloud Summit's decision to ban leaf blowers is based on ADEQ projections. Prior to 1995, unregulated engines in leaf blowers produced more that 200 pr/hr-hr Total Hydro Carbons (THC). In 1995 EPA Phase I certified blower engines improved emissions 30% to 180 gr/hp-hr THC. In a year from now EPA Phase II certified engines will begin to make another 70% emissions improvement to 37 gr/hp-hr THC and NOx. ADEQ has projected emissions savings banning leaf blowers will bring to year 2020. First I question if the ADEQ used EPA Phase I engines as a model for their projections. More importantly, did the ADEQ consider the next 70% improvement in blower emissions by EPA certified Phase II regulations?

Current Phase II regulations extend to 2006. Who knows what the EPA will expect in the next phase of improvements. I believe the decision to ban leaf blowers is based on inaccurate ADEQ projections.

Response:
ADEQ relied on fuel combustion emission estimates made in a document entitled “Non-Road Engine Emission Inventories for CO and Ozone Nonattainment Boundaries, Phoenix Area.” prepared for the U.S. EPA by Energy and Environmental Analysis, Inc., in 1992. Unit population was grown to 2000 population and then projected through 2020 by the ITAG tool. Fugitive dust estimates were based upon CARB emission factors and assumptions regarding blower population and daily usage. Fuel combustion accounted for approximately 20% percent of the visibility improvement while fugitive dust emissions accounted for approximately 80% of the visibility improvement on the worst 20% average winter day, the visibility improvement values are 0.03dV and 0.13dV respectively.

Comment:
The commenter reiterates the previous comment that all leaf blowers manufactured since 1995 have had to meet EPA Phase I regulations. EPA Phase II regulations begin in another year. It does not seem fair to ban a product certified to meet these emission requirements. The commenter also believes it is not legal for the State of Arizona to ban leaf blowers. Every state (except California) is subject to EPA nonroad engine emission regulations in the Federal Clean Air Act. Federal law does not allow states to preempt these regulations.

Another commenter maintains that the proposed ban on leaf blowers is preempted under section 209(e)(2) of the Clean Air Act.

Response:
Both EPA and the United States Court of Appeals for the D.C. Circuit have determined that implied preemption under section 209(e)(2) applies only to "quantitative levels of emissions" and to "ancillary enforcement mechanisms for those limits, such as certificates and inspections." It does not apply to "in-use_ limitations such as restrictions on use in certain areas (see Engine Manufacturers Ass'n v. EPA, 88 F. 3d, 1075, 1093-94 (D.C. Circuit)). The Summit, therefore, disagrees with this comment.

Comment:
The commenter refers to published ADEQ documents in August 2000 that stated all yard and garden equipment cause 1% of the Valley's brown cloud. Leaf blowers make up only a fraction of this 1%, yet in December 2000 the Brown Cloud Summit made banning leaf blowers their number 2 priority.

Response:
All the measures were evaluated using the same process and presented in the Final Report in two ways - visibility improvement and cost effectiveness. This measure ranked second highest for visibility improvement and fourth highest for cost effectiveness (see pages 9 and 10).

Comment:
The commenter voices concern that the provision may also apply to the use of leaf vacuums and would not support a provision banning the use of leaf vacuums.

Response:
The measure recommended by the Brown Cloud Summit includes only leaf blowers.

Comment:
The commenter feels that a ban on leaf blowers will be extremely hard to enforce, will make removing debris from a xeroscaped difficult and believes will result in loss of property values. He also questions why grass is not planted besides freeways and medians.

Response:
As mentioned, leaf vacuums would be allowed under the ban. Some have also switched to using rakes and/or brooms to clear areas of landscape debris. In response to the question regarding loss of property value, there are no indications that the lack of leaf blowers will diminish a property's value. Certainly, there are many properties where the home or business owner did not use leaf blowers and successful sales were made. The commenter is requested to refer questions regarding highway/freeway construction and maintenance activities to the Arizona Department of Transportation or the Maricopa County Department of Transportation, the agencies responsible for the maintenance of the freeways and medians.

Comment:
The commenter believes that leaf blowers and lawnmowers are targeted as major contributors to the brown cloud problem.

Response:
Lawnmowers restrictions were not addressed by the Brown Cloud Summit and are not included in the recommended measure.

Comment:
One commenter suggests that electric leaf blowers used in backyards don't generate material (particulate)...but agrees with keeping commercial guys from blowing it into the street.

Response:
Electric leaf blowers do not generate fuel combustion exhaust as gas powered ones do, but they do add particulate matter to the air.

Comment:
The commenter suggests that leaf blower noise levels have been reduced from 120 to 65 decibels. Landscapers, through associations and equipment dealers, were schooled in the proper operation of blowers to minimize noise generation by using only as much power as necessary to accomplish each task and to operate only during reasonable hours. Some environmental special interest groups latched on to the emotional supposition that dust from a blower's output duct significantly increases dangerous small-particle PM pollution. There are no definitive studies to demonstrate the generation of small-particulate PM pollution. There are no definitive studies to demonstrate that brooms and rakes do not cause the same kinds of dust. There have been no definitive studies to demonstrate that without or efficient and economical alternatives.

Response:
Although reduction of neighborhood noise is a potential benefit of the measure, the Brown Cloud Summit only evaluated the potential air pollution benefits associated with a ban of leaf blower use. The Summit agrees with the statement that there are no definitive studies to estimate leaf blower fugitive dust emissions, although for the purposes of the Summit, the best available, and, most recent, information was used (see

California Air Resources Board, A Report to the California Legislature on the Potential Health and Environmental Impacts of Leaf Blowers, February 2000).

Comment:
The commenter suggests that tennis clubs need gas blowers to remove debris from courts for safety reasons. Gas leaf blowers remove debris from tennis courts much faster than electric units.

Response:
The Summit is unaware of any studies to verify the commenter's claim.

Comment:
The commenter recommends adopting the CARB Tier II emission Standards and the noise standard of 65dB ANSI Std. Also suggested was an education program and incentives for electric leaf blowers.

Response:
Because the CARB and federal standards are now very similar, adopting CARB standards would

not provide for adequate emission reductions beyond what will be achieved via the new federal standards.

Comment:
The commenter points out that the only product banned by the Summit is the leaf blower. The reason is because there was no landscape/power equipment manufacturer on the Summit.

Response:
All the subcommittees and the Summit provided for extensive public input since the Summit's first meeting in June 2000. In addition, information regarding the actions of the various groups was made available through the Internet and mass faxes.

Comment:
The commenter urges the Summit to strike the outright ban of leaf blowers from the final recommendations to the Governor for the following reasons; 1) there was no green industry representatives on the Brown Cloud Summit, 2) all measures included training, restrictions, testing, etc. except leaf blowers which was an outright ban, 3) a bias against leaf blowers by the committee because it goes beyond the scope of the committee when discussing VOC and CO emissions, and neighborhood noise, 4) the report does not consider the hours of usage or numbers of units of leaf blowers compared to automobiles, trucks, construction equipment, etc. 5) no consideration was given to the benefits of green landscaping that is maintained by leaf blowers. Further, no consideration was given for the net marginal difference between the consequences of blower usage versus that of a broom or leaf rake.

Response:
While it is true that no green industry members were included on the Summit, their representatives did convey their concerns to the full Summit, as did other interested groups.

Comment:
Two commenters suggest that a complete ban is extreme and less drastic measures should first be considered. Less stringent ban should apply to companies or contractors that create a cloud of dust when attempting to move a pile of dirt with a blower rather than picking it up. A method of notifying companies of a violation and future fines could help accomplish reductions. Or, as an alternative, the ban should be voluntary.

Response:
These type of operational restrictions could provide emission reductions, although less that a complete ban.

Comment:
One commenter inquired about the number of leaf blowers compared to other brown cloud sources.

Response:
With regard to the number of leaf blowers in the Maricopa County area, estimates in a document entitled "Non-Road Engine Emission Inventories for CO and Ozone Nonattainment Boundaries; Phoenix Area", Prepared for U.S. EPA by Energy and Environmental Analysis Inc. in 1992, were used by the Summit. The document estimated 34,093 leaf blowers in Maricopa County in 1992. The number for 2000 was then calculated by adjusting the 1992 number to population increase in the

Valley. The result was 50,048 units in Maricopa County in 2000.

Comment:
One commenter requested the supporting documentation and data used to quantify fugitive dust resuspended by leaf blowers, stating that dust emissions from leaf blowers were not part of the inventory of fugitive dust sources. They also recommended that a the recommendations from the referenced CARB report be included in the Description and Background section of the report. A second commenter requested a review of the emission reduction estimates for leaf blowers, pointing out that the conclusions are counter-intuitive, especially recognizing that dust only contributes 7-9 percent of the visibility problems.

Response:
The supporting document referenced for the Ban Leaf Blowers section are as follows:

California Air Resources Board, A Report to the California Legislature on the Potential Health and Environmental Impacts of Leaf Blowers, February 2000.

Dulla, Robert G, Earl Withycombe, Sierra Research Inc., Report prepared for Maricopa Association of Governments, Particulate Control Measure Feasibility Study, Volume II, Appendices, January 24, 1997.

Maricopa Association of Governments, Revised MAG 1999 Serious Area Particulate Plan for PM-10 for Maricopa County Nonattainment Area, Appendices Volume Three, December, 1999.

Report of the Governor's Air Quality Strategies Task Force, Recommended Control Measures for Ozone, Carbon Monoxide, and PM10, February 17, 1998.

In order to address both comments, a review of the emission estimate is of value. The leaf blower analysis was done in two parts. First, the reductions from exhaust emissions were in put into the assessment tool. This used as a data source the 1992 nonroad emission inventories for CO and ozone nonattainment boundaries and grew the population out from 1992 to 2000. The reduction to the pollutants were then subtracted from the nonroad emission inventory and run through the assessment tool to obtain visibility improvement data.

Units TPY									
Year	Population	Unit Pop.	Op hr/yr	HC	CO	NOx	PMtot	PM10	PM2.5
1992	2112101	34093	19	326	952	1	3	0.15	2.85
2000	3100000	50048	28	478	1397	1.47	4.40	0.22	4.18
Convert to tpd				1.31	3.83	0.004	0.121	0.006	0.0115

Secondly, the reduction from fugutive dust was calculated. We used the particulate emission rate information described in the CARB report and averaged the emission rates for the various surfaces. The values are shown in Table 5.0. The total fugitive dust emissions are shown in Table 5.1.

CARB data Table 5 Leaf Blower Estimated Emission Factors (g/hr)

Emission Factor	Paved Roadway	Shoulder	Curbs/Gutters	Average
PM10	48.6	1012	1030	697
PM2.5	23	479	488	330

Equipment usage assumptions used in the calculation include:

- Daily hours of operation (hr/day) 2
- Annual hour of operation (hr/yr) 730
- Number of gas blowers in use per day 2850
- Number of electric blower in use per day 150 (15%)
- Total number of units in use per day 3000
- Total number of unit in Valley 50000
- Percent of total units in operation per day 6%

Table 5.1 Total Fugitive Dust Emissions

	lbs./day	tpd	tpy
PM10	9221	4.611	1152.75
PM2.5	4368.26	2.1841	546

These estimates were subtracted from the paved road dust inventory since there was no specific source category for leaf blower dust in the fugitive emissions inventory.

The CARB report, as referenced, is recognized to contain the most complete analyses of original data on the potential health and environmental impacts of leaf blowers. The BCS task was specifically defined to review emissions that affect winter visibility. It is appropriate to reference the CARB study for exhaust and fugitive dust emissions. It is beyond the scope of the BCS to discuss CARB's recommendations that include analysis for the impact of leaf blowers on noise pollution, public health, and operator occupational health risks. Interested parties are encouraged to obtain the entire CARB report, including their recommendations, via the Internet. http://www.arb.ca.gov/msprog/leafblow/ leafblow.htm.

Comment:
If you take away the gas powered blowers, than the yard maintenance people will carry around generators to run electric ones.

Reponse:
The leaf blower ban as recommended in the Draft Final Report includes a ban on gas and electric leaf blowers.

Comment:
Check the States use of leaf blowers. Commenter has observed leaf blower use around the state capitol buildings. Suggested that we (the State) should at least set an appropriate example before recommending the mandatory ban.

Response:

The Summit thanks the commenter for the comment.

Comment:
Not opposed to leaf blower ban but will increase water use.

Response:
The Summit thanks the commenter for the comment.

Comment:
Did not see time schedule for leaf blower ban, should be enacted as soon as possible.

Response:
The Stationary and Area Source Subcommittee report to the Brown Cloud Summit suggests that if legislation was enacted in 2001, the program could take effect in 2002 or 2003 depending on the need for rulemaking activities.

Comment:
An explanation of enforcement is necessary. Do the costs of the program include enforcement?

Response:
No, enforcement cost was not considered in the analysis.

Comment:
Several commenters argued that a ban on the use of leaf blowers in Area A would constitute a taking of private property without just compensation in violation of the Fifth and Fourteenth Amendments to the United States Constitution.

Response:
A regulatory restriction on the use of personal property that deprives the owner of some but not all beneficial uses of the property is not a taking. If the leaf-blower ban is adopted, owners will still be able to use the blowers outside of Area A or sell them to other persons living outside the area. The Summit therefore disagrees with this comment.

EXPANSION OF AREA A

Seven commenters expressed support of the expansion of Area A to the west as described in the Draft Final Report. Specific comments and responses follow.

Comment:
One commenter suggested that the expansion should include the entire state in order to make a statement and address the problem.

Response:
Earlier evaluations by ADEQ of Statewide expansion of Area A programs such as the Vehicle Emissions Inspection Program, showed that they would produce a very small reduction in air pollution in the Valley at enormous cost.

Comment:
One commenter stated the control measure seems to provide an insignificant return and is very expensive and suggests that the Summit revisit the measure in order to best utilize funds.

Response:
The Summit thanks the commenter for the comment.

Comment:
One person recommended that any further discussion about expansion of Area A (far east valley) be immediately killed, since the current program has not resulted in any significant reduction in pollutants.

Response:
The Area A expansion to the east valley (Apache Junction, Gold Canyon, etc.) took place in 1998 with some control measures (ie. vehicle emissions inspection program) not taking effect until January 2001. The current recommendation by the Brown Cloud Summit proposes to expand Area A to the high growth areas to the west, including Buckeye and Surprise.

Comment:
Why was Apache Junction not previously included in Area A?

Response:
Apache Junction was relatively remote and outside of the developed metropolitan area in 1978, when the original boundaries of Area A were developed. Legislation adopted in 1998, included Apache Junction in Area A due to the rapid growth in that area.

REPLACE GENERATORS WITH ELECTRIC POWER AT CONSTRUCTION SITES

There were two comments in support of the replacement of generators with electric power at construction sites. Specific comments and responses follow.

Comment:
One commenter asked how contractors are going to build anything without their generators and asked if generators on motor homes will be banned.

Response:
"The Replace Generators with Electric Power at Construction Sites" control measure was not described as a widespread ban on the use and operation of portable generators. Rather, the measure specifically focused on portable generators used at residential construction sites in Area A where live power could be provided. The measure will not apply to motor home generators.

Comment:
One commenter asked how would electricity be accessed prior to power being at a construction site and who will pay for electricity used? He also questions if a general contractor will want to keep track of what subcontractors use for each job site.

Response:
The control measure would require that temporary electrical power be installed at the residential construction site prior to construction activity beginning. As with costs for generators, live power would be included in the construction cost for the home.

Comment:
One commenter voiced concern that sometimes it is not possible to get electrical power to a site because of its location. He also expressed concern that the measure would severely hurt the construction industry.

Response:
The control measure applied only to residential construction in Area A. Electricity for residential buildings is generally available in the area. Remote sites that are not residential in nature or construction outside of Area A would not be subject to the requirement.

Comment:
One person indicated that generators are needed for construction and maintenance of buildings, especially welding. He suggested that Sky Harbor be looked at and efficient transportation system be considered as a solution.

Response:
The control measure applied only to residential construction in Area A.

Comment:
One commenter, who owns a small business that sells, services, and manufactures construction equipment for contractors, stated it is unfair to contemplate enacting legislation that would ban all generators from job sites. He also stated that contractors would face huge loss of assets (portable power and air equipment) and that legislation would be restraint of trade and could violate Sherman Act and State Uniform Antitrust Act.

Response:
The measure recommended by the Brown Cloud Summit only included replacement of generators at new residential construction sites. It does not include commercial or other construction activities. *The report will be revised to clarify the extend of the measure.*

Comment:
One person indicated that a portable generator ban would only hurt the small people who do not have a lot of clout in the political arena and that bans will not produce a noticeable reduction of the brown cloud. He suggested that the big culprits are vehicles and airplanes.

Response:
The control measure was not described as a widespread ban on the use and operation of portable generators. Rather, the measure specifically focused on portable generators used at residential construction sites in Area A. Salt River Project (SRP) and Arizona Public Service (APS) have both run pilot programs to supply temporary power at residential constructions sites.

Comment:
One person asked how much pollution is really going to be reduced by replacing generators?

Response:
Emission reduction from replacement of gasoline generators at construction sites with electrical power was estimated to result in 1292 tons per year (tpy) of carbon monoxide, 29.3 tpy VOC's, and 1.2 tpy of PM_{10}.

Comment:
One commenter recommended that any legislation regarding the "Replacing Generators with Electrical Power at Construction Sites" be carefully structured as not to restrict the use of temporary generators, but rather to encourage the power companies to speed up the process of installing the permanent power.

Response:
The measure recommended by the Brown Cloud Summit only includes replacement of generators at new residential construction sites.

Comment:
One commenter requested us to confirm the relationship between emission reductions and haziness improvement. The replacement of generators at construction sites indicates a reduction of 58 tons per year of PM10 and a deciview improvement of 0.06. The PM10 efficient street sweeper measure indicated a reduction of 14.7 tons per day, and a deciview improvement of 0.05.

Response: Visibility improvements are not necessarily linear relationship to reduction of a single pollutant species. Different pollutant species have different extinction coefficients. Reduction in combustion emissions has a larger benefit to visibility improvement than reduction in dust. Elemental carbon, one of the prime pollutants in combustion emissions, both absorbs light and scatters light. Reduction of elemental carbon has roughly ten times more impact to visibility than reductions of other fine materials. The results of the visibility assessment tool pollutants and speciated pollutants for each of these measures are listed below.

Worst 20% Avg.. Winter Day – 2006 Change Between Control Option and Baseline Forecast Scenerio

	Pollutant or	Replace Generators with Electric Power at Construction Sites (Tons)	PM10 Efficient Street Sweepers (Tons)
Change in Base Emission Inventory (tons)	PM10	**-0.381**	**-2.944**
	PM2.5	-0.347	-0.590
	NOx	-2.402	0.000
	SOx	-0.312	0.000
	VOC	-0.521	0.000
Change in Speciated Emission Inventory (tons)	Organic Carbon	-0.015	-0.083
	Elemental Carbon	**-0.068**	**-0.006**
	Other Fine Materials	-0.007	-0.507
	Coarse Materials	-0.034	-2.354
	NOx	-2.402	0.000

	SOx	-0.312	0.000
	VOC	-0.521	0.000
	Change in Haziness (dV)	**0.06**	**0.05**

ADDITIONAL FUNDING FOR PM10 EFFICIENT STREET SWEEPERS

Comment:
One person indicated that from their observations street sweepers seem to kick up more dust then they clean.

Response:
The recommended measure suggests obtaining additional funds to purchase PM_{10} efficient street sweepers which collect particulate matter. This would reduce the visible dust cloud described.

Comment:
One commenter indicated that they have observed sweepers/vacuum trucks being operated when they were obviously full and suggests better operator training is needed.

Response:
Additional operator training could be beneficial in reducing emissions from street sweepers. Additional benefit could be gained by utilizing PM_{10} efficient street sweepers described in the measure.

Comment:
Two commenters suggested using street vacuums rather than street sweepers.

Response:
The PM_{10} efficient street sweepers described in the measure operate much like a vacuum by containing particulate matter with filtration systems.

AGRICULTURAL DUST

There was one general comment which suggested leaving the farmers alone. Specific comments and responses follow.

Comment:
Fourteen commenters suggested dust control for agricultural operations to reduce emissions from farm implements and equipment.

Response:
In an effort to address agriculture's contribution to $PM_{10,}$ the Governor's Best Management Practices (BMPs) Committee was created and charged with developing an agricultural PM_{10} general permit, for the Maricopa County portion of the PM_{10} nonattainment area, that would address the need for controls on agricultural operations. BMPs were to be identified that focused on feasible,

effective, and common sense practices while minimizing negative impacts on local agriculture. The new permit requires that farmers implement at least one BMP for each of the following three categories: Tillage and harvest activities, non-cropland, and cropland. Several ways in which farmers can meet these requirements include:

- Performing no tillage or soil preparation activity when the wind speed at the commercial farm site is more than 25 miles per hour.
- Growing multi-year crop, pasture or orchard, which results in less soil disturbance than crops grown yearly.
- Creating an artificial or woody vegetative wind barrier.
- Operating farm vehicles or farm equipment on unpaved private farm roads at speeds not to exceed 20 miles per hour.
- Installing a "track-out control system" which is a device that removes mud and soil from a vehicle before the vehicle enters a public road.
- Planting strips of alternating crops within the same field to reduce wind erosion.
- Manipulating a soil surface to produce or maintain clods, which are less likely to erode than unaltered soil.

The permit was adopted in May 2000 and each commercial farmer has until December 2001 to determine which BMPs to implement.

Comment:
One person suggested a fleet of crop dusters equipped with micro-fine sprayers that could spray a very fine mist of purified water three mornings a week. This would transfer many of the pollutants from the air to the ground.

Response:
In researching this suggestion, no pilot projects of this type could be identified. Barriers to implementing this measure include potential high costs, and localized climate changes, which could be either beneficial or undesirable.

BAN FIREPLACE USE

Comment:
One person suggested a two-pronged approach local media campaign, namely that fireplaces should be EPA approved and only used sparingly.

Response:
Additional public education is valuable in reducing the Brown Cloud. Maricopa County Environmental Services Department currently provides educational information to the public with regard to fireplace use.

Comment:
One commenter suggested tax incentives for conversion of existing wood-burning fireplaces to non-polluting propane gas.

Response:
Arizona state law (ARS 43-1027) already provides a tax incentive for conversion of existing wood-

burning fireplaces to those meeting the EPA regulations. This law has been in effect since 1994. It allows taxpayers to subtract from their Arizona gross income an amount equal to the cost, exclusive of taxes, interest and other finance charges, but not more than five hundred dollars, for the conversion of an existing wood fireplace to a qualified wood stove, wood fireplace or gas fired fireplace and nonoptional equipment directly related to its operation on property that is located in this state.

Comment:
One commenter indicated that fireplaces which are not compliant with EPA standards emit CO_2 and particulate matter.

Response:
All new installations of fireplaces within Area A, or rebated conversions are required to meet the EPA certification. The Maricopa County Web site lists how to get this information.

Comment:
Twelve commenters expressed support for additional restrictions on woodburning fireplaces or a requirement to use natural gas/propane.

Response:
There are several restrictions already in place for woodburning fireplaces: 1) New installations in Area A need to be clean burning fireplaces, 2) A tax incentive for retrofits of existing fireplaces, 3) A restriction on burning when monitoring or forecasting indicated the carbon monoxide/particulate standard is likely to be exceeded. The Stationary and Area Source Subcommittee did review potential additional restrictions. One control measure considered but not recommend would have restricted commercial fireplaces and restrictions on residential and commercial outdoor firepits.

Comment:
Three commenters expressed opposition to the current fireplace restrictions.

Response:
Fireplace and/or woodstove use is permitted, except during “no burn days”. Woodburning produces pollutants and fine particulate matter that are harmful to the environment and human health. There are currently programs for installation of cleaner burning fireplaces for new construction and conversions. The only proposed change to current restrictions of fireplace regulations made by the Brown Cloud Summit is the inclusion of the expanded area A into current area A fireplace restrictions.

Comment:
One person suggested prohibiting fireplace burning or outside burning without a permit.

Response:
See the above comment with regard to restricting fireplace burning. Currently, outside fires for the purpose of human warmth and cooking are exempt from needing a burn permit. Revisions to State/County rules would be required to implement such a permit requirement. Outside fires for the purpose of weed abatement require a permit from the appropriate state or county agency.

INDUSTRIAL SOURCES

Comment:
One person suggests better monitoring of existing facilities and limits of use in the wintertime when the inversion layers cause pollution to build up. New facilities are fine, but not in residential areas.

Response:
Industrial facilities are required to meet extensive reporting requirements, and are audited regularly. As to seasonal operating restrictions, one of the more major sources of visibility impairing pollutants, utilities and other generators of electricity, are at more minimal emission levels during winter just in the course of doing business. New facilities are required to go through extensive review and must meet all applicable federal, state, and local requirements before building and starting operations.

Comment:
Three commenters mentioned that it was important to review industries' contribution to the Brown Cloud and not just look at control measures from gas and diesel vehicles. Two commenters suggested tightening up industrial emission controls during major inversion periods.

Response:
On-road and off-road vehicles contribute 81% to the winter visibility impairment. Therefore, the Summit focused considerable attention on potential control measures from gas and diesel vehicles. Stationary and industrial sources collectively contribute 19% to visibility impairment on the worst days. Of this 19%, 9.4% is from dust, 7.5% from wood combustion and only 1.9% from natural gas combustion (S.L. Heisler, August 8, 2000 presentation). The Stationary and Area Source Subcommittee did extensive review of NOx control measures implemented locally compared to control measures used in other states. Several potential control measures for industrial emission were discussed. But, most low NOx technologies are retrofitted onto equipment and then used year round. There were no control measures found that could be employed seasonally, or only when there were air quality alerts.

Comment:
One person indicated that one proposal that was not recommended was retrofitting old sources with NOx technology and that the San Tan power plant is the biggest single stationary source of NOx in the Valley, yet they asked to be exempt from this when they got Title V permit.

Response:
SRP has filed an application with the Maricopa County Environmental Services Department to install new emission control technology on the existing four gas turbines at Santan. This technology, known as Dry Low NO_x Combustors, will reduce emissions of oxides of nitrogen (NO_x) by up to 80% from current levels.

Comment:
Three commenters expressed the following concerns about the San Tan Power Plant. One person expressed opposition to the San Tan Power Plant, one person asked why SRP is building a power plant smack in the middle of residential areas. And one commenter inquired about the San Tan plan expansion"off-sets" proposed to allow more pollution. Another commenter suggested a total ban of power plants in the Valley or such sources should be given tax incentives for building outside the

Valley. Another commenter suggested the industries located on the Durango Curve and I-17 area pollute the air more than any other sources in the Phoenix.

Response:
Major stationary sources of air pollution and major modifications to such facilities are required by the Clean Air Act and Maricopa County rules to obtain an air pollution permit before commencing construction. The process is called new source review (NSR) and is required whether the major source or modification is planned for an area where the National Ambient Air Quality Standards (NAAQS) are exceeded or an are where air quality is acceptable. During the permit process there is opportunity for public hearings and public comment. The Title V permit for the San Tan Power Plant has been issued. Specifics regarding this plant and its permit are outside the scope of the Brown Cloud Summit.

CLEANER FUEL

Comment:
One commenter suggested a statewide solution on diesel, not just Maricopa County.

Response:
The Summit did not consider this measure; however, upcoming plans to address Regional Haze in the West, may have to consider this option.

Comment:
Fourteen comments were received supporting the implementation of cleaner burning diesel.

Response:
The Summit adopted this measure and thanks you for your interest.

Comment:
Seven comments were received against the implementation of cleaner burning diesel because of its increased cost and the belief that it would be ineffective.

Response:
Although cleaner burning diesel will be more expensive than conventional diesel, this measure has the proven potential to reduce pollutants that cause the brown cloud and adversely affect public health. Much of the improvement to California's air quality can be traced to requirements for cleaner burning fuels, including cleaner burning diesel.

Comment:
Regarding the mandatory adoption of CARB diesel control measure, do the anticipated improvements to air quality take into account the expected increase in fuel consumption resulting from the lower fuel efficiency of this product? It is my understanding that vehicle mileage suffers tremendously with this product where it has been tried elsewhere. If so, this will result in a substantial increase in fuel costs for motor carriers (and all diesel users) with potentially little to no improvement in air quality.

Response:
Documented mileage reductions with CARB diesel are in the 1 to 2 percent range. As emissions reductions were calculated on the basis of the amount of work output, any impact the mileage reduction might have on emissions was taken into account. Also, the additional cost associated with the mileage reduction was included in the evaluation of CARB diesel costs and visibility benefits.

Comment:
Six comments were received suggesting that biodiesel / other formulations (e.g., water emulsion) be promoted.

Response:
This measure was considered but not adopted by the Summit. According to Mr. Joe Jobe with the National Biodiesel Board, several school districts in the Phoenix metropolitan area have considered using biodiesel in their fleet of school buses. For more information on biodiesel, please visit the following Web sites: Department of Energy's Web site, www.afdc.doe.gov, and Biodiesel organization Web site, www.biodiesel.org, or contact Mr. Joe Jobe, Executive Director of the National Biodiesel Board at 1-800-841-5849 or joejobe@sockets.net.

Comment:
Six comments were received supporting the implementation of ultra-low sulfur diesel and diesel vehicle retrofits.

Response:
The Summit proposed a voluntary early implementation of ultra-low sulfur diesel for use in diesel engines retrofitted with oxidation catalysts and particulate filters for public fleets measure.

Comment:
With respect to Voluntary Early Implementation of Ultra-Low Sulfur Diesel for Use in Retrofitted Diesel Vehicles, one commenter suggested that tax breaks could be used as a potential incentive.

Response:
Such an incentive may be appropriate; however, the advocates of this control measure did not propose any specific incentives.

Comment:
One commenter suggested that the emissions benefits of the Voluntary Early Implementation of Ultra-Low Sulfur Diesel for Use in Retrofitted Diesel Vehicles were overstated because many public fleets are already committed to converting their vehicles to natural gas and the potential to use the retrofits as offsets for new stationary sources.

Response:
These factors, while not specifically identified, were taken into account by using a range of effectiveness of this control measure. Given this information, the upper-bound estimate may not be achievable in reality. The Summit has made an appropriate adjustment to the estimated benefit of this program.

Comment:
Four comments were received suggesting that low sulfur diesel be promoted.

Response:
The Summit proposed a voluntary early implementation of ultra-low sulfur diesel measure for public fleets and thanks you for your suggestion.

VISIBILITY STANDARD

Comment:
One person suggested that the visibility index be published via news or weather each day and that it be related to some standard that we can track.

Response:
Such a proposal has been made by the Visibility Standards Subcommittee. A description of the plan is included in the Brown Cloud Summit's draft report to the Governor.

Comment:
Please advise how Deciview Improvement values shown on page 10 of the draft report were determined. Point of confusion: Voluntary Vehicle Repair and Retrofit Program has less than one-third emissions reduction in all categories than does the Mandatory Adoption of CARB yet it shows nearly FOUR times the improvement. How does less pollutant reduction provide MORE Deciview Improvement?

Response:
Deciview improvement values are calculated for the percentage reduction of pollutants for a proposed control strategy by taking into account the light extinction efficiency of the pollutants from that pollution source and the overall amount of pollution released in a day by that pollution source. Because the VVRR is more effective at reducing the specific visibility-impairing pollutants found in the Phoenix metropolitan area than CARB fuel formulations, lesser VVRR emission reductions improve visibility more than the greater CARB fuels' emissions reductions.

Comment:
A visual measurement of air pollution isn't the most efficient way to determine the level of pollution. The city should reduce pollution for health purposes not aesthetics. Air samples and more scientific methods need to be researched.

Response:
The intent of the visual measurement is to provide quantitative hourly data on visual air quality as a person with normal vision would see through the atmosphere. The Executive Order from Governor Hull asked the Summit to consider both health effects and aesthetics in reducing the Brown Cloud. More costly and labor-intensive samples of particles and other pollutants causing the Brown Cloud will be simultaneously collected and analyzed on a less frequent schedule to understand the causes of visual impairment reported from the visual measurements. The relationship of these measurements is explained in Appendices 2 and 3.

Comment:
The Summit has not identified a standardized measurement component to the recommendation to ensure consistent tracking of future improvement/degradation of the "Brown Cloud".

Response:
The Summit has identified interim visibility targets of 250, 260, and 275 days in 2001, 2002, and 2003, respectively, with one or more 6-hour daylight hour periods of 25 miles or greater average visibility. These

data will be calculated from the continuous measurements of the transmissometer described in Appendix 2. During the 2001-2003 time frame, the Summit also recommended that ADEQ conduct a scientific public survey to determine what distance and quality of views are desired in the Phoenix metropolitan area. Finally, the Summit recommended that the causes of visibility impairment be analyzed periodically; these analyses are scheduled to be reported in 2003, 2006, and 2010.

Comment:
An "educational" element should be added -- directed at the general public by age group. It should include explanations of cause, effect, and what can be done about it (the brown cloud). Get people interested and doing ANYTHING that contributes to the brown cloud will become a social taboo over time.

Comment:
I would like to see public service announcements on TV & radio regarding the ill effects of air pollution, and how each citizen needs to take responsibility for alleviating the problem.

Response:
The Summit considers public education activities a vital part of reducing the Brown Cloud. The public survey planned for 2001-2002 will be the first step to address your comments at an individual level. Subsequent public education activities will likely build on the public survey results, and your ideas will be incorporated.

Comment:
I read over this report and am appalled at the nearsightedness of not only government officials but also the representatives of big business. First off I would like to clarify something. If you are going to make a new scientific standard that uses the same scale as an existing standard, you better explain that the scale is logarithmic. The representation for sound pressure level (dB) is a logarithmic curve with a base of 10. Your dV is just a takeoff of Denver's AQI level. If I didn't know better your page is just a rip-off of theirs. I don't if you did any real thinking of your own to come up with this bogus standard. Maybe you get together with the NIST lab and find out what unit is really used to describe visibility.

Response:
The deciview scale is logarithmic, as human visibility perception studies show that a person of average vision needs to see an improvement or degradation of 10% at a given level of air pollution to see a perceptible difference in visual air quality. Visibility is measured using the units of inverse kilometers or megameters, a quantitative measurement of the amount of light removed by air pollution and the natural scattering of the atmosphere over a specified path length. A 10% change in the inverse kilometer or megameter reading is equal to 1.0 deciviews.

Comment:
In reading through the visibility goals which are being discussed for the years 2001, 2002, and 2003,

I notice that the numbers chosen, (250, 260, and 275 days of 25-mile or greater visibility) have already been met for the past 4 out of 6 years. In fact, in both 1998 and 1999, the actual values were over 300.

In order to show goals which show definite improvement, either a larger number of days with visibility greater than 25 miles should be chosen, or perhaps getter, use the same number of days, but set the target visibility to something greater than 25 miles.

Given the current recommendations, the valley could potentially do nothing, and still achieve the goals proposed by the committees. This seems counter to the essence of air quality improvement.

It is also possible that since the target values for these years may be used as a starting point for determining goals for the subsequent daily visibility index, we will be selling ourselves short of achievable goals in the longer term.

Response:
The Summit evaluated combinations of various averaging times (1, 2, 3, 4, 6, and 12 hours) and visual range targets (equal to or greater than 25, 40, and 60 miles) to select the 25-mile and 6-hour combination. While the number of days for the target values are presently being met, visibility data presented in the draft report and Appendices 2 and 3 suggests that visibility has worsened since the mid-1990s. The target values will not be used in the index setting process; the daily index value will be based on a quantitative public survey to determine what distance and quality of views are desired in the Phoenix metropolitan area. Finally, the Summit recognized that periodic analyses of the causes of visibility impairment are needed; the 2003 report recommended by the Summit will evaluate visibility for the 1994-2003 time period, using the days/year target approach before converting to the use of the index in 2004. Future reports in 2006 and 2010 will address how well the Phoenix metropolitan area is meeting the daily index level.

Comment:
The Visibility Standards Subcommittee selected the interim index (25 miles at least six hours per day) without the benefit of seeing that level of visibility on a computer generated image. Now that the final report includes a picture of the visibility selected, it is important to note that visual aid was not available to the Subcommittee.

Response:
The Summit has not selected an interim index, but instead has selected specific numbers of days/year with a measured visibility level as target values for the 2001-2003 time period. The minutes do not show whether the image described above was or was not seen at any of the Visibility Standards working group meetings. The minutes of the working group's meetings indicate that the group evaluated combinations of various averaging times (1, 2, 3, 4, 6, and 12 hours) and visual range targets (equal to or greater than 25, 40, and 60 miles) before selecting the 25-mile and 6-hour combination.

Comment:
This summary indicates that visibility readings will be reported daily. I suggest that you check the recording from the Subcommittee meeting. As I recall, the Subcommittee members expressed a concern about adopting an index level similar to Denver's. We considered recording the levels and reporting them annually rather than daily. The potential numbing effect of daily reporting poor

visibility was discussed as an issue during the presentation by Michael O'Neil of O'Neil Associates on October 13. The Subcommittee frequently discussed daily recording and annual reports.

Response:
The Visibility Standard Subcommittee's working group specifically discussed the daily reporting of a future visibility index value at their October 25 meeting. Orally, two of the three working group members indicated that they supported daily reporting. Mr. O'Neil also stated in his presentation that frequent reporting helps to shape public policy and provides each citizen the opportunity to form an opinion. Finally, the Summit recognized that periodic analyses of the causes of visibility impairment are needed; the 2003 report recommended by the Summit will evaluate visibility for the 1994-2003 time period. using the days/year target approach before converting to the use of the index in 2004. Future reports in 2006 and 2010 will address how well the Phoenix metropolitan area is meeting the daily index level.

Comment:
It is recommended that an expert in atmospheric optics and visibility edit Appendix 2. The light-extinction coefficient is the most important parameter for quantifying the effect of air pollution on visibility, but it is not properly defined in this Appendix or anywhere else in the Draft Report. Appendix 2 should also be revised to contain descriptions of the relation between visual range, the deciview haze index, and the light-extinction coefficient that are both technically accurate and easily understood by the layman.

At a minimum, the word ""amount"" should be changed to ""fraction"" in the first bullet on page 48 in Appendices.pdf so this bullet reads, ""Inverse kilometers — the fraction of light that is removed from a sight path per kilometer."" During twilight, the total amount of light in a sight path changes by a factor of ten in a short time with the result that the amount of light removed by light extinction also changes by a factor of ten. Both the fraction of light removed and the light-extinction coefficient are not affected by changes in the illumination. However, even this fix is not entirely adequate, because the light-extinction coefficient can be larger than 1 inverse kilometer.

Several sections of the Draft Report indicate that the transmissometer is the instrument of choice for measuring visibility impairment. Monitoring in more than one location with this instrument is difficult because it is expensive to purchase, install, calibrate, and operate. Monitoring in more than one location is desirable because it is well known that the brown cloud is not uniform in the metropolitan area. Also, fog and rain, which are not related to air quality, interfere with transmissometer measurements. Editing transmissometer data to remove these unwanted interferences is a subjective process that is open to error. (How does the data editor distinguish between a light fog and a dense haze?) The separate measurement of light scattering by particles with a nephelometer and light absorption by particles with an aethalometer is cost effective and produces data free from these unwanted interferences. Heaters can be programmed to heat the sample air when it is foggy or very humid. This permits monitoring the pollutants responsible for the brown cloud even when it is foggy. These measurements could easily be added to several existing air quality monitoring sites in Maricopa County. They are now being used successfully at a number of monitoring sites in the San Joaquin Valley in California.

Response:
Appendix 2 will be revised accordingly for the final report. We also appreciate your recommendations about using transmissometers versus nephelometers to track hourly or sub-daily

visibility. The Summit has decided to recommend a combination of both instruments in an expanded urban visibility monitoring network, but use the path light extinction data from multiple transmissometers to report on a daily basis.

Comment:
Visibility Index: Presently, there is no EPA standard for urban visibility and there is no EPA model to evaluate visibility. As discussed at the subcommittee meetings, it is premature to set a visibility target at this time. Also, please delete “daily” when referencing the visibility index and reporting to reflect the numerous discussions throughout the committee process that “daily” may not be appropriate.

Response:
EPA does have a standard for urban visibility; regulating visibility outside of a specified list of 156 national parks and wilderness areas through the secondary particulate matter standards (both $PM_{2.5}$ and PM_{10}). EPA secondary air quality standards are designed to control, on a national basis, the welfare effects of particulate air pollution, including visibility. Based on the Visibility Standard Subcommittee’s working group recommendations, the Summit has selected specific numbers of days/year with a measured visibility level as target values for the 2001-2003 time period. The Visibility Standard Subcommittee’s working group specifically discussed the daily reporting of a future visibility index value at their October 25 meeting. Orally, two of the three working group members indicated that they supported daily reporting.

Comment:
It is important to note that EPA is conducting a project to obtain information regarding public opinions on visibility impairment due to air pollution. It is recommended that the EPA information be reviewed prior to expending State resources on a duplicative public survey effort. The costs for the periodic visibility assessments appear to be excessive. The committee discussion seemed to indicate that ADEQ staff would prepare periodic reports summarizing the index data and evaluating changes in visibility throughout the area.

Response:
Thank you for your suggestion about the EPA survey. The periodic assessments include analyses of sources causing the Brown Cloud, as well summarizing the data. The costs for these assessments are quite reasonable for the accuracy and level of detail they entail.

Comment:
Comment: Kudos on suggesting a visible "air quality index" to daily assessments, along with employee alerts at major Valley companies!
Because individual people have much different perceptions about what is "visually acceptable", I don't agree that surveying random people should be a basis for acceptable standards, when coupled with the free market. Rather, actual concrete definitions of exactly how much fine particle dust and other pollutants can penetrate the membranes of living beings should set the threshold of acceptability. Let's aim high at first, then revise our goals if they prove to be unattainable under any circumstance.

Response:
Survey research into human perception of visual air quality has been going on for many years, and results of those surveys indicate that the quality of the survey instrument would be the most critical

portion of determining a visibility index value. Future analyses and reports in 2006 and 2010, as recommended by the Summit, will address how successful the Phoenix metropolitan area is in meeting the future daily index level.

Comment:
An example of the need for a more organized and integrated approach is seen in the discussion of the projected benefits of the proposed control measures. One would think that the proposed control measures and their projected benefits, in terms of improved visibility, would be highlighted in the body of the report. Unfortunately, that is not the case. The first quantitative estimate of the visibility improvements is found in a table on Page 9 of the 11-page Draft Final Report. There, the Summit's 19 proposed control measures are ranked in terms of estimated impairment improvements for the year 2020 (from 0.47 deciviews to 0.001 deciviews). However, to learn about deciviews and, more particularly, to learn how the Phoenix visibility ranks in term of deciviews, the reader must know, or care enough, to go to Appendix 2.

On Page 2 of Appendix 2, the reader will find a table that depicts Phoenix visibility, in terms of visibility impairments, for the years 1994 through 1998. The reader will find the average visibility impairment of the dirtiest 20% of the days in 1998 was about 26 deciviews, about 15 deciviews for the average 20% of the cleanest days in 1998 and about 20 deciviews for the average reading of the remaining 60% of the days in 1998.

The reader's first impulse would be to subtract the impairment improvements from the Phoenix visibility impairments to estimate the resulting benefits if all proposed measures were implemented. By adding all projected improvements shown on the aforementioned Page 9 and subtracting that sum (1.4 deciviews) from the 26 deciviews mentioned above, the reader could conclude that the average impairment for the dirtiest 20% of the days would be reduced to about 24.6 deciviews.

The reader might later question whether it is appropriate to calculate improved visibility by subtracting impairment improvements projected for 2020 from impairments actually measured in 1998. In other words, would that small projected improvement nevertheless be overly optimistic?

Unfortunately, the reader will find no projections of the Phoenix visibility through 2020 with or without the projected improvements that are estimated to result from the proposed control measures. As a result, the reader has no way of knowing what the relative impact of the proposed control measures will be.

If the Summit lacked the time and money to project future visibility (or visibility impairment), it should say so and not leave the reader guessing about such a fundamental issue. The lack of projected future visibility or visibility impairments in terms of deciviews raises questions about the need for the proposed controls. If major visibility improvements are projected on the basis of other initiatives, one might question whether there is need for the proposed control measures. One the other hand, one might question the whole rationale of the proposed measures if the visibility impairment is expected to significantly increase over the next twenty years despite the other initiatives.

Components of the Brown Cloud

If one assumes that the reduction from 26 deciviews to 24.6 deciviews is a reasonable

approximation of the benefits of the proposed control measures, questions arise about the adequacy of the control measures. Are the control measures not stringent enough or are they only addressing part of the problem? That is a very important question. If the proposed control measures account for only a small percent of the total emissions, how can the measures be expected to produce meaningful air quality benefits? That, too, is an important question given the fact that the proposed measures might detrimentally affect the livelihood of some individuals and create wealth for others in the form of emission credits.

To further identify contributing factors, the Summit should decide whether its goal is to reduce the brown cloud, improve visibility, or both. This is a necessary decision because the factors that contribute to visibility impairment may not contribute to the brown cloud to the same degree, if at all, and vice versa. Nevertheless, the Summit appears to consider the brown cloud to be indistinguishable from other forms of visibility

problems. For example, the information shown in Appendix 2 does not allow the reader to determine how many of the “dirty” days were brown cloud days.

The presentation of the visibility data in terms of averages as shown on Page 2 of Appendix 2 is not very useful. Not only does it not distinguish between brown cloud days from other days of visibility impairment, it does show the deciview readings for the dirtiest and cleanest days. It does not even show what part of the year that the dirtiest days occurred. A far better presentation would be daily visibility readings. Hourly, six-hour and daily averages will be needed if meaningful statistical analyses are to be performed, which analyses are necessary if one is to begin to understand the factors that contribute to the visibility impairment not addressed by the proposed control measures.

Given that the proposed control measures apparently will reduce visibility impairment by only about six percent, it is important to understand the factors that contribute to the other 90 plus percent of the impairment. The Draft Final Report does not describe what statistical analyses were performed to identify factors that contribute to poor visibility and/or brown cloud days. This raises the question whether the analyses were performed and not reported. If the analyses were performed, the results and methodology should be reported. If they were not performed the Summit should request the time and funds necessary for the analyses to be performed and delay its recommendations on control measures.
The statistical analyses can and should include the evaluation of a wide range of variables relative to transmissometer data (hourly to daily averages) and reconstructed light extinction data. The variables should include all factors that would affect emission strength, all factors that limit dispersion of contaminants in the atmosphere, the age and chemistry of the receiving air mass, meteorological factors such as relative humidity that affect visibility measurements, and the direction of the wind relative to the emission sources and monitoring instruments.

The evaluation of the aforementioned variables using multiple regression techniques could help identify the other factors that cause the 90 plus percent of the impairments not addressed by the proposed control measures. Some, maybe most, of the factors causing the impairments could be beyond the Summit’s jurisdiction but, whatever the amount, the public deserves to know.

Representative Measurements

The transmissometer data and the reconstructed light extinction data are surely representative of

some portion of the air zone that the Summit is charged with improving. What part and how much of the zone is the issue. If the data are not sufficiently representative of the entire zone, representative data need to be collected before fair and cost-effective control measures can be developed. Alternatively, the control measures should be included only in areas where the data are considered to be representative.

Consider the transmissometer data. Transmissometers respond only to atmospheric constituents that cross the transmissometer's light path. The data which the Summit must use reflects the constituents that crossed a three-mile light path that crosses a residential, light commercial area near the center of the Phoenix. To what extent can the Summit be sure that the data from that light path is representative of the Phoenix air quality or the brown cloud? The same questions apply to the reconstructed light extinction data.

Another related question relates to the degree of correlation between the transmissometer data and the reconstructed light extinction data. If there is not a strong correlation between the two sets of data, one could question whether the data are representative of the same air quality. If they are not, one could question whether the reconstructed light extinction data used to develop/evaluate the proposed control measures can lead to reasonable projections of future visibility impairments, as measured by the transmissometer.

The Draft Final Report's Appendix 4 describes in very general terms the plans of the Visibility Standard Subcommittee with respect to additional monitoring for the next nine years. Unfortunately, the types, numbers and locations of monitoring stations were not specified. Thus, members of the public are not given the opportunity to comment on the adequacy of one of the most important aspects of a visibility reduction program.

Understanding Uncertainty

There are a large number of uncertainties to consider in a problem as complex as the brown cloud. Some of the uncertainties involve the validity of data and complicated assessments of monitoring equipment and analytical techniques. For purposes of this discussion, it is assumed that the data used to develop and evaluate the proposed control measures meet the criteria specified in EPA's Guidelines on Speciated Particulate Monitoring and Visibility Monitoring.

The lack of data and the lack of time and money to collect needed data, and to perform needed analyses, have required the Summit to base its proposed control measures on a number of broad assumptions. It is therefore important that the assumptions be clearly identified and that a written discussion of the resulting uncertainties be provided for public review prior to the finalization of the Summit's report. The uncertainty analysis will help members of the public understand the relative importance of assumptions and factors that influence the accuracy of projected costs and benefits of the proposed control measures.

Need for an Expanded Study

My comments are not intended as a criticism of the Summit's work to date. Rather, they are intended to show that there are enough unanswered questions to warrant the establishment of a monitoring network that is specifically designed to generate the information needed to develop fair and cost-effective control measures.

Response:
The Summit and its Subcommittees discussed and decided upon the methods used to evaluate the present and future visibility benefits and impacts. The Summit agreed that the present frequency and magnitude of the Brown Cloud, as described in the Executive Order establishing the Summit, were unacceptable. Deciviews were then chosen as the metric so that the benefits of control programs could be directly compared, and the effects of those control programs on both "clean" and "dirty" Brown Cloud days could be evaluated. The analyses used to understand the causes of the Brown Cloud (as it causes visibility impairment) are described in Appendix 3 of the draft Report. The factors listed in the comments, including relationships between optical visibility, air pollution sample, and meteorological data were considered in apportioning the causes of the Brown Cloud. The effects of monitor location and the resulting representativeness of the measurements were a concern of the Summit. The plan suggested by Visibility Standard Subcommittee in Appendix 4 anticipates that the number of monitoring sites and the area covered in the monitoring network will need to increase. ADEQ will make the plans for this expanded network available before installing the monitors. The comments about uncertainty have merit; the Summit recommended that a analysis report be prepared by 2003 to evaluate visibility more completely for the 1994-2003 time period, before converting to the use of the index in 2004. Future reports scheduled for 2006 and 2010 will provide additional analyses.

LONG TERM CAP AND TRADE VISIBILITY PROGRAM

Comment:
One person asked if companies sell their credits to non-complying businesses? Another commenter asked if business "credits" for performance can be sold and traded and if this means that a company that is 50% under the required limit - and receives "credit" for doing so - can then give or sell these credits to another company on an ongoing basis to allow them to operate at 50% above the allowable limits?

Response:
Cap and trade is a policy approach to controlling large amounts of emissions from a group of sources at costs that are lower than if sources were regulated individually. The approach first sets an overall cap, or maximum amount of emissions per compliance period, that will achieve the desired environmental effects. Authorizations to emit in the form of emission allowances are then allocated to affected sources, and the total number of allowances cannot exceed the cap. Individual control requirements are not specified for sources. Sources are required to completely and accurately measure and report all emissions and then turn in the same number of allowances as emissions at the end of the compliance period. A cap and trade program calls for substantial reductions of pollutants currently released into our air. Credits cannot be used by a facility to violate emission limits contained in the facility's permit.

Comment:
One commenter asked what "market-driven strategies" means?

Response:
Emissions trading is a market-based alternative to conventional regulation which permits sources that can reduce air pollution emissions beyond the levels required in permits to benefit by selling those credits from the extra reductions to new or expanding sources that must offset increases in

emissions. This also gives sources a strong incentive to develop new methods for efficiently reducing emissions.

Comment:
One person indicated that the good air quality behavior credits idea is incomplete and suggested skipping the incentive program and jump right to mandatory environmental standards with expensive penalties for violations.

Response:
The intent of the report was to provide a conceptual description of a backstop emission banking program. The Summit recommends legislation to establish a board of affected members of the public to design the program, as well as authority for ADEQ to develop the program.

Comment:
One person indicated that the "trading" of credits between industries would be a "zero sum" poker game and that to get real improvement we must strive for hard number improvement ('setting a target for emission reductions") so that our growth doesn't force us to go to the backstop program. The commenter also
indicated that he faulted a board of "affected members" as not being the public's health but industries "pocketbook"

Response:
The idea of the program is to in fact strive for "hard number improvement' whereby a series of declining targets are established through time meaning that the overall pool of emissions goes down, and to achieve those air quality improvements voluntarily is certainly more desirable than triggering the backstop program. The intent of the board is to provide the affected sources a voice in how the backstop program works, but it would still be a regulatory program that is operated by ADEQ.

Comment:
One commenter suggests an even stronger initiative would be to require mandatory use of what engineers call Best Available Control Technology (BACT), with substantial fines and penalties for those that do not comply and suggests the "board of affected members of the public" is crucial.

Response:
The idea behind the Cap and Trade program is that it can provide the emission reductions equivalent to BACT, but do so in a cost effective fashion. Since BACT applies to industrial sources only, the proposed program scope of the program could in fact surpass BACT by getting reductions from a broader spectrum of sources.

Comment:
One commenter questioned the potential effectiveness of the Cap and Trade program, for example, 1) what the targets are, 2) what pollutants are traded and how they are traded, 3) the trading is an open process, 4) how monitoring is done, 5) how enforcement is accomplished. A second commenter suggested the program would need to be mandatory to be effective. A third commenter recommended that onroad mobile sources be eliminated from the program.

Response:

The Cap and Trade program as described in the report is intentionally broad. The Summit believes it is possible to use market based mechanisms to achieve aggressive goals more cheaply, and agree that there are certainly many details to be worked out. The commenters have pointed out some of these issues appropriately and these issues will be noted as the program is more fully developed.

Comment:
Appendix 1, Page 9, Paragraph 2: One commenter suggests deleting the word "all" from line one and stated that the backstop program may address many sources, but it is not possible to include all sources.

Response:
This change will be made in the Final Report.

Comment:
Appendix 1, Page 9, Paragraph 2: One commenter suggested adding a sentence to the end of this paragraph clarifying the opposing conclusion of the Visibility Subcommittee: "In separate meetings the Visibility Subcommittee strongly recommended against the use of a visibility standard or index as a regulatory tool." Alternatively, you could delete the last sentence. A second commenter suggested that the discussion regarding setting the targets based on the visibility index be deleted from the text. The commenter also stated that the program should be emission based.

Response:
The Visibility Standards Subcommittee working group recommended, and the Summit agreed, in keeping with the Executive Order establishing the Summit, to establish targets for future visibility in the metropolitan area. The Subcommittee working group recommended interim visibility targets of 250, 260, and 275 days in 2001, 2002, and 2003, respectively, with one or more 6-hour daylight hour periods of 25 miles or greater average visibility. These data will be calculated from the continuous measurements of the transmissometer described in Appendix 2. During the 2001-2003 time frame, the Subcommittee working group also recommended, and the Summit agreed, that ADEQ conduct a scientific public survey to determine what distance and quality of views are desired in the Phoenix metropolitan area, and implement the reporting of a daily ambient visibility index value. To implement a "cap and trade" emissions control program, it is necessary to establish targets, and one way is to link them directly to a publicly-determined ambient visibility metric. It is also possible to design the targets as emissions-based, linked to the ambient visibility metric as the desired outcome, with the success of the control program determined by periodic assessments. The latter is what the Summit agreed upon.

OFF-ROAD ENGINE STANDARDS

Comment:
One commenter suggested that mandatory bans on portable equipment and generators would be improper. And that federal requirements with regard to lead time and implementation of equipment standards would preclude the adoption of California's NTE standards.

Response:
There are presently no mandatory engine standards for mobile sources in the Summit recommendations.

TAXES AND STANDARDS BASED ON FUEL EFFICIENCY / EMISSIONS

Comment:
Three commenters suggested that fuel efficiency standards be set.

Response:
Fuel efficiency standards are under the exclusive jurisdiction of the federal government. Further, emissions standards for light duty, gasoline-fueled vehicles are set independent of gas mileage (i.e., an SUV that consumes 12 mpg must meet the same or very nearly the same standards as a compact vehicle that achieves 40 mpg).

Comment:
Five comments were received suggesting indexing registration fees to vehicle fuel efficiency.

Response:
Since emissions standards for light duty, gasoline-fueled vehicles are set independent of gas mileage (i.e., an SUV that consumes 12 mpg must meet the same or very nearly the same standards as a compact vehicle that achieves 40 mpg), such a measure was not considered by the Summit.

Comment:
Six comments were received suggesting that the gasoline tax be increased and apply these revenues to a clean air fund.

Response:
While this approach would provide additional resources that may be applied to air pollution programs and research, the State Constitution currently limits the use of gasoline taxes to building and maintaining roadways. Further, increasing the cost of automobile use without providing a range of convenient and safe alternatives would have a disproportionate adverse impact on people with fixed and lower incomes who may not have ready access to transit.

Comment:
Six comments were received suggesting that gasoline tax be increased as a disincentive for vehicle use and fuel inefficient vehicles.

Response:
Research has consistently shown that small increases in gasoline taxes have hardly any impact on reducing its consumption. In order to have an impact on reducing gasoline use, taxes would need to be increased to by at least one dollar. As such, such an increase in the cost of automobile use without provision of a range of convenient and safe alternatives would have a disproportionate adverse impact on people with fixed and lower incomes who may not have ready access to transit.

Comment:
Eleven comments were received suggesting that emissions-based registration fees and higher sales taxes be adopted.

Response:

This approach to reducing emissions from motor vehicles has had a full hearing in the Legislative process on more than one occasion. Close examinations of methods for implementing such a program that were accurate, fair, and affordable have shown it to be infeasible at this time.

Comment:
Three comments were received suggesting that people be charged by the amount of emissions that their cars produce (mileage X emission rate).

Response:
This approach to providing disincentives for polluting vehicles is logical. However, close examinations of methods for implementing such a program that would be accurate, fair, and affordable have shown it to be infeasible at this time.

Comment:
One commenter suggested that tax credits be given to people who can prove that they have an older car that they rebuilt (e.g., to a "hot rod") that runs cleaner than when the car was originally factory built.

Response:
Some high-performance engine rebuilds do not improve the emissions of older vehicles. An incentive program for fixing high-polluting, older vehicles already exists. The Voluntary Vehicle Repair and Retrofit programs operated by Maricopa and Pima Counties provide financial assistance to owners of older vehicles that have failed emissions inspections, providing for repair and, where feasible, retrofitting with more modern emissions control systems.

Comment:
Ten comments were received suggesting that more controls/restrictions be placed on SUVs.

Response:
Fair and effective methods of restricting SUV use that also improve air quality are not available at this time. Current emissions standards for these vehicles are either as stringent or nearly as stringent as those for standard passenger vehicles. By 2006, SUVs will be even cleaner than they are today and no more polluting than a compact car with respect to carbon monoxide, hydrocarbons and oxides of nitrogen.

Comment:
One commenter suggested that speed limits be enforced to save gas and reduce pollution and speeding fines be used to fund projects to improve air quality.

Response:
Mass emissions of gaseous and particulate pollutants vary little between speeds of 45 and 70 miles per hour. In general, emissions increase with decreasing speeds below 45 mph, so better enforcement of speed limits in this range would be counter-productive for air pollution control.

Comment:
One commenter suggested that additional fines (e.g., $100) be levied on motorists that cause accidents because they cause additional traffic congestion which in turn causes more air pollution.

Response:
An increase in traffic congestion from an accident would be dependent on the time, day, and road that an accident occurred. For example, an accident on I-17 during rush hour would cause more traffic congestion, than an accident on 3rd Street at 6 am on a Sunday morning. Thus, it may not be equitable to fine the same amount to all drivers that are responsible for an accident.

RESTRICT DRIVING

Comment:
Eight comments were received suggesting that the use of drive-thru windows be restricted.

Response:
This pollution control measure has been under consideration on several occasions in the past two decades. Research has shown that drive-thru services are insignificant contributors to regional air quality problems.

Comment:
One commenter suggested that mandatory no-drive days be implemented.

Response:
This pollution control measure has been under consideration on several occasions in the past two decades, and has been rejected as draconian and difficult to enforce.

Comment:
One commenter suggested that all commercial traffic on streets and highways in Area A be restricted to operating at night.

Response:
This approach may, at best, provide only marginal air quality benefits. It may even exacerbate air pollution because night-time inversions will prevent air pollution from these vehicles from being dispersed. Truck restrictions during peak traffic times have been evaluated as potential air pollution control strategies in air quality plans for ozone, carbon monoxide and particulate matter, and considered to be infeasible.

TRANSPORTATION DEMAND MANAGEMENT AND ALTERNATIVE TRANSPORTATION MODES

Comment:
Five comments were received suggesting that the use of public transportation be promoted.

Response:
Several programs exist to promote public transportation. As the transit tax initiatives translate into increased bus service, more people will find using transit to be a convenient and safe alternative to driving.

Comment:
Eighteen comments were received suggesting that more bicycle lanes and enhanced bicycle facilities be built.

Response:
All major cities in the Phoenix Metro area have put considerable resources toward improving bicycle facilities. The primary benefits of improved bicycle facilities are for quality of life aspects (e.g., increased safety, mobility) other than air quality. As such, it is better addressed as a transportation, not an air quality issue.

Comment:
Twenty-nine comments were received suggesting that compressed work schedules and telecommuting be promoted.

Response:
Compressed work schedules and telecommuting are already promoted through the Maricopa County Travel Reduction program. Independent efforts are in place to expand the use of telecommuting. For more information, visit the Regional Public Transportation Authority Web site at www.valleymetro.maricopa.gov.

Comment:
Seventy-one comments were received suggesting that mass transit / light rail be promoted. One commenter suggested that development impact fees be used to build public transit. Five comments were received suggesting that a subway be built. Four comments were received suggesting that a monorail be built. Two comments were received suggesting that available parking (park and ride) for access to public transportation access points be increased. Forty-four comments were received suggesting that zero-fare bus routes be implemented. One commenter suggested that there be mandatory carpooling on freeways.

Response:
While improved public transit can provide a small air quality benefit, it will not reduce pollution from commercial, delivery and inter-regional/state (drive-through) traffic. For that reason, air quality improvements are just one relatively small factor to consider regarding expansion of public transit. The Summit did not consider this measure because it is being explored by the Governor's Transportation Vision 21 Task Force. That Task Force will present a set of transportation alternatives to the public in January and February 2001. See their Web site at www.dot.state.az.us/vision21.

Comment:
One commenter suggested that "e-government" be promoted so that citizens could conduct more business with government offices over the internet and through other methodologies.

Response:
Increased use of "e-commerce" technology (using the Internet to conduct business) to conduct government business with citizens would reduce traffic and pollution. This approach to commerce is currently being promoted through an number of government and private sector initiatives, and is rapidly building in popularity. As such, additional promotion is not seen as necessary.

Comment:
Three comments were received suggesting that available parking be decreased and/or increase parking fees.

Response:
This approach is under the jurisdiction of individual cities and towns, and has been considered for inclusion in air pollution control plans for carbon monoxide, ozone and particulate matter.

Comment:
Two comments were received suggesting that the State should subsidize bus passes, like major cities in area.

Response:
The State currently subsidizes 50% of the cost of bus-passes for State employees. Expansion of this subsidy would require legislative approval.

Comment:
Sixteen comments were received suggesting that carpooling and more carpool lanes be promoted.

Response:
The Maricopa County Travel Reduction Program currently promotes car and van pooling. For more information, visit the Regional Public Transportation Authority Web site at www.valleymetro.maricopa.gov.

Comment:
Four comments were received suggesting that tax credits or other incentives be instituted to encourage alternative commute mode use. Sixteen comments were received suggesting that large and small companies be given tax incentives or be required to meet a minimum percentage of their employees telecommuting, car/vanpooling, or having compressed work schedules.

Response:
The Maricopa County Travel Reduction Program currently requires major employers to promote telecommuting, alternative transportation modes (e.g., car/vanpooling, transit, bicycling) and compressed and alternative work schedules. For more information, visit the Regional Public Transportation Authority Web site at www.valleymetro.maricopa.gov.

Comment:
Eight comments were received suggesting that incentives be provided to employees / employers for employees living closer to work.

Response:
The Summit thanks the commenter for this suggestion.

Comment:
One commenter suggested that motorcycle and scooter use be encouraged over using cars.

Response:
Motorcycles and scooters have not been subject to the stringent emissions controls that have been

required for motor vehicles. As such, they produce more pollution per mile than the average gasoline-powered car or truck, providing they have 4-cycle engines. Motorcycles and scooters with 2-cycle engines (ones that require oil to be mixed in gasoline) produce magnitudes more pollution per mile than do the average cars or trucks.

TRAFFIC FLOW IMPROVEMENT

Comment:
Nine comments were received suggesting that enhancement of I-10 bypass of Phoenix area be supported.

Response:
A bypass of the Phoenix metro area has been promoted since 1996, when signs were installed on I-10 west of Buckeye and south of Casa Grand, encouraging through traffic to use U.S. 85 and I-8. Additional incentives for using this bypass were considered by the Summit, but not specified.

Comment:
One commenter suggested that reversible carpool lanes be used on the freeway.

Response:
While such lanes have been constructed as part of other freeway systems (e.g., I-395 in northern Virginia), the Maricopa County freeway system has been developed with one-way car pool lanes. Further consideration of this issue is in the venue of Maricopa Association of Governments and the Arizona Department of Transportation.

Comment:
Three comments were received suggesting that HOV lanes on freeways be converted to full use lanes. One commenter suggested that HOV on-ramps be built. Eleven comments were received suggesting that the freeway system be improved.

Response:
These issues were not considered by the Summit because it is in the venue of Maricopa Association of Governments and the Arizona Department of Transportation.

Comment:
Eight comments were received suggesting that traffic signal / freeway on-ramp signal synchronization be improved.

Response:
This is currently a requirement under state law, and is being implemented by the cities and towns in the area and Maricopa County. The current system in place in Phoenix is near optimum performance. Traffic flows greater than roadway capacity, driver behavior and other limitations will always prevent traffic signal synchronization from providing completely uninterrupted traffic flow on arterial streets.

Comment:
One commenter suggested the following: I recommend that the Brown Cloud Summit report

include a recommendation for a study to be made to determine the merits of adding Smart Radars to Assist Traffic Signals (SmartRATS) to some of the valley's intersections. SmartRATS are not intended to replace the existing computer network for controlling traffic signals, but rather it would be a key addition to this system that would dynamically adjust the duration of the green light on the primary street to minimized stopping and waiting on the secondary street.

SmartRATS include radars that determine the speed of each on-coming vehicle and their distance from the intersection for each direction of that intersection. SmartRATS also include a computer that analyzes this information along with data from the existing traffic control computer system to dynamically adjust the duration of the green light for the primary street to minimize the stopping and waiting on the secondary street. In essence, SmartRATS allows drivers to do what they would like to do and that is to enter intersections when there is no on-coming traffic.

Response:
Radar-assisted traffic lights to optimize traffic flow could indeed reduce idling time and idling air pollution. Provided that their development and deployment were feasible to use with, or as a replacement for existing traffic signal synchronization systems, this measure could, in the long run, yield some tangible benefits in both fuel saved, pollution reduced, and driving time reduced. The commenter's suggestion will be forwarded to the traffic engineers at the Arizona Department of Transportation and the cities and town in the Phoenix area. Your lengthy, detailed analysis is appreciated

Comment:
One commenter suggested that train activity during rush hour be limited.

Response:
This issue was not considered by the Summit because it is in the venue of Maricopa Association of Governments and the Arizona Department of Transportation.

Comment:
One commenter suggested that the number of turn signals be increased or the existing turn signals be improved.

Response:
This issue was not considered by the Summit because it is in the venue of cities and towns, Maricopa County, the Maricopa Association of Governments and the Arizona Department of Transportation.

Comment:
One commenter suggested that "Slower Traffic Stay to the Right" be enforced.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
Two comments were received suggesting that large trucks be required to only use the right lane or two right lanes of all metro freeways.

Response:
This issue was not considered by the Summit because it is in the venue of Maricopa Association of Governments and the Arizona Department of Transportation.

Comment:
One commenter suggested that fees be charged for driving in downtown area during rush hour, etc. Use fees for public transportation.

Response:
The Summit thanks the commenter for the suggestion.

REPAIR / RETROFIT / PURCHASE SUBSIDIES

Comment:
Thirteen comments were received supporting funding for the gasoline Voluntary Vehicle Repair and Retrofit Program (VVRR). Four comments were received suggesting support for funding a diesel VVRR program.

Response:
The VVRR is a particularly cost-effective program that will, hopefully, become a priority for funding.

Comment:
Three comments were received suggesting that gasoline VVRR be made mandatory.

Response:
Several limitations exist that would make such an approach difficult: suitability of vehicles for repair and retrofit, availability of retrofit equipment, financing and availability of auto repair technicians. Based on past experience of Maricopa County, which operates this program, it may be difficult to do more than double the number of vehicles participating.

Comment:
One commenter suggested that subsidies be provided to owners of pre-1980 cars to buy post-1980 used cars.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
One commenter questioned whether the assumption was made that ultra low sulfur fuel would be used for the Diesel VVRR. Because this fuel will not be available for individually owned vehicles, the emission benefits should assume a lower impact.

Response:
The emissions benefits of this program were estimated based on the use of technologies that will work with current diesel fuel.

Comment:
One commenter asked why the Diesel VVRR was limited to model year 1990 and older trucks.

Response:
The reason this control measure was limited to the oldest trucks is because the biggest increments of change in emissions standards for diesel trucks occurred through the 1991 model year. Applying a repair and retrofit program to the highest emissions vehicles provides the best cost-effectiveness for such a program.

EMISSION STANDARDS, TESTING AND ENFORCEMENT

Comment:
Four comments were received suggesting that stricter fines or requirements for smoking vehicles be implemented.

Response:
No fines or regulatory requirements exist for vehicles identified as "smokers." Diesel vehicles registered in the greater Phoenix and Tucson areas are required to pass an annual test of tailpipe smoke density. While smoke density is the emission standard currently in use for diesel vehicles, a fair and accurate test for excessive smoke from gasoline powered vehicles has yet to be devised. Until a standard can be developed, it will not be possible to impose a fine on an owner of a smoking gasoline-powered vehicle.

Comment:
Nine comments were received suggesting that smoking vehicle reporting be enhanced.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
Twenty-six comments were received suggesting that all vehicles driving in Area A be required to meet emissions standards (including stricter standards for older cars, winter visitors, NAFTA trucks).

Response:
Mechanisms for requiring vehicles of nonresidents to be emissions tested have been explored on a number of occasions over the last decade. While there would probably be emissions reductions benefits of such an approach, legal and effective ways of implementing tests for nonresidents have eluded policy makers. One of the control measures suggested requires testing of nonresident diesels in conjunction with existing roadside pullover inspection programs. This is possible because the equipment used to test for diesel smoke is portable and inexpensive. If this program is implemented, trucks from other countries driving through the Valley could be subjected to testing and sanctions for failing the test.

Comment:
Four comments were received suggesting that all vehicles driving in the state be required to meet emissions standards.

Response:
Statewide vehicle emissions testing has been evaluated on many occasions in the past two decades. It has been shown to have very small air pollution reduction benefits, at a very high cost, and for that reason, has not gained favor.

Comment:
One commenter suggested that the state work with the Federal government to implement vehicle emission tests nationwide.

Response:
This comment is similar to the previous comment calling for statewide vehicle emissions testing. Statewide vehicle emissions testing has been evaluated on many occasions in the past two decades. This measure has been shown to have very small air pollution reduction benefits, at a very high cost, and for that reason, has not gained favor. The same would most likely be true for nationwide vehicle emissions testing with respect to its impact on air quality in the Valley.

Comment:
One commenter suggested that VEI tests be required every year instead of every two years.

Response:
Annual testing of vehicles was evaluated when the current enhanced emissions inspection test was first debated in 1993. About 85% of the current vehicle population is required to take the enhanced emissions test. Because the enhanced test takes considerably longer than the current annual test, the testing network would need to be greatly expanded, which would, in turn, greatly increase the cost of the enhanced test. Evaluations of vehicle emissions testing programs have concluded that only a small amount of emissions benefit is lost by going from annual to biennial testing. As such, the potential air quality improvement would be small and the costs very high to require vehicles currently subject to biennial testing to be tested annually.

Comment:
Four comments were received suggesting better enforcement of emission standards.

Response:
Improved enforcement of vehicle registration requirements has been a priority for ADOT. This is the primary mechanism for enforcing vehicle emissions standards.

Comment:
Two commenters suggested that all 2-cycle gasoline engines be banned or severely restricted.

Response:
While this is a good idea, very few, if any, 2-cycle engine cars and only about 500 to 600 2-cycle motorcycles are registered in Maricopa County, or 0.03 percent of the total vehicle population. While 2-cycle engines produce much more pollution than 4-cycle engines, the vast majority of them are in use for off-road purposes (mostly hand-held equipment, like string trimmers, leaf blowers, chain saws and lawn mowers).

Comment:
One commenter suggested that gasoline golf carts be outlawed and estimates that there may be one

million gasoline golf carts in Arizona.

Response:
Gasoline powered golf carts, because they are not road-worthy as licensed motor vehicles, have not been subject to the stringent emissions controls that have been required for motor vehicles. As such, they produce more pollution per mile than the average gasoline-powered car or truck. The "Nonroad Engine Emission Inventories for CO and Ozone Nonattainment Boundaries Phoenix Area", August 1992, U. S. Environmental Protection Agency, has 56,000 gasoline golf carts in the inventory. According to the 1999 Maricopa Association of Governments PM10 plan, gasoline golf carts contribute 1.7 tons per year to the overall inventory of 20,930 – a percentage of 0.008%. While their contribution is small, measures to require electric golf carts may still be worthwhile, since their conversion would eliminate their gaseous and particulate emissions and would be a small step in the right direction. A similar control measure was considered by the Off-Road Mobile Controls Subcommittee but was not adopted.

Comment:
One commenter suggested that a way be found to eliminate all diesel vehicles.

Response:
At the present stage of vehicle technology, it would be infeasible to eliminate all diesel vehicles, since diesel vehicles are the primary mode for transporting and moving heavy loads.

Comment:
Five comments were received suggesting that roadside testing of all diesels be required.

Response:
While this may yield an air quality benefit, the practicality and safety of conducting a Phoenix area pull-over program for testing all diesels would make such a program very difficult to implement.

Comment:
One commenter suggested that roadside testing of cars (random) be required.

Response:
The Summit thanks the commenter for the suggestion. At present, reliable and affordable technology does not exist to conduct such a test on light-duty vehicles.

Comment:
Three comments were received suggesting that VEI/Smog Dogs be eliminated.

Response:
Based on studies of the emissions benefits and costs of the Arizona program, the current Vehicle Emissions Inspection Program is the most effective locally-implemented pollution control strategy in place today. The great improvements made for reducing carbon monoxide and ozone levels to compliance with federal health standards is, in part, the result of this program.

The remote sensing program, also known as Smog Dogs®, was eliminated in 2000 legislation because of the relatively high cost and marginal effectiveness of the program. ADEQ was charged with conducting studies to develop a more effective remote sensing program.

Comment:
Three comments were received suggesting that Smog Dogs be brought back.

Response:
The remote sensing program, also known as Smog Dogs®, was eliminated in 2000 legislation because of the relatively high cost and marginal effectiveness of the program. ADEQ was charged with conducting studies to develop a more effective remote sensing program. As the technology improves, it may be possible to implement a new, more effective remote sensing program.

Comment:
One commenter suggested that emission controls be required in Pinal County.

Response:
Apache Junction and parts of Pinal County near the town of Queen Creek were included in the emissions testing area in 1998. The legislation postponed vehicle emissions testing requirements until January 1, 2001.

Comment:
Two commenters suggested that Vehicle Emissions Inspections either should not be expanded to the East Valley or are unwarranted.

Response:
As the Valley has grown, the Apache Junction and Queen Creek areas have become bedroom communities for people that work and conduct commerce in Maricopa County. Since rapid growth continues in this area, it is important to make sure that vehicles registered in those areas run cleanly.

Comment:
Five comments were received suggesting that emission limits for vehicle emissions inspection (diesel and gas) be lowered and the cost of the inspection increases proportional to emissions.

Response:
The ability to index fees to emissions has been evaluated on several occasions. Consistent and comparable emissions measurements for all vehicles tested would require that the test be longer and special test equipment be installed for some types of vehicles (e.g., motorcycles and constant 4-wheel drive vehicles) and, as a result, an expanded emissions testing network would need to be purchased and built. The expense of this option has prevented it from being considered further.

Comment:
One commenter suggested that California new car standards be adopted.

Response:
This option was considered in 1998, and rejected by the Legislature. With the implementation of the National Low Emissions Vehicle program, and the more stringent federal new car standards beginning in 2004, the incremental benefit of adopting California standards would be very small.

Comment:
Fourteen comments were received suggesting that all heavy duty vehicles be required to run cleanly.

Response:
Statewide vehicle emissions testing has been evaluated on many occasions in the past two decades. It has been shown to have very small air pollution reduction benefits, at a very high cost, and for that reason, has not gained favor.

Comment:
One commenter suggested that all diesel controls be made mandatory and implemented statewide.

Response:
Statewide vehicle emissions testing has been evaluated on many occasions in the past two decades. It has been shown to have very small air pollution reduction benefits, at a very high cost, and for that reason, has not gained favor.

Comment:
One commenter suggested that California NTE standards for diesel engines be adopted.

Response:
This measure has been recommended by the Summit, details are contained in Appendix 1.

Comment:
Two commenters opposed adoption of California's not-to-exceed (NTE) testing procedures for diesel engines. Both commenters argued that Arizona's adoption of the NTE procedures would violate the four-year "lead-time" and three-year "stability" requirements of section 202(a)(3)(C) of the Clean Air Act, which they claim applies to all states under the preemption provisions of section 209(b) of the Act.

Response:
The Summit disagrees with the commenters' contention that Arizona's adoption of the NTE testing procedures, [including the Euro III European Stationary Cycle Emission Test Procedures], is subject to section 209(b) of the Clean Air Act. California is the only state that is authorized to obtain a waiver from preemption of new vehicle standards under section 209(b). Section 177 of the Act allows any other state to adopt California's new vehicle standards, as long as both California and the state promulgate the standards at least two years before the commencement of the model year to which the standards would apply. Manufacturers are protected from inconsistent requirements by section 177's prohibition of a "third vehicle" standard.

It is the Summit's understanding that California and EPA are currently discussing whether the NTE procedures are subject to a current waiver, and if they are not, whether the procedures are eligible for a waiver under section 209(b). The Summit believes California's position that the procedures are already subject to a waiver or eligible for a new waiver is sound, but that is in any case a matter to be resolved by EPA. Based on the analysis in the report of the On-Road Mobile Controls Subcommittee, the Summit has concluded that imposition of the NTE procedures would not impose an undue burden on the heavy duty engine or heavy duty vehicle manufacturing industry. The Summit recommends expeditious adoption of the NTE procedures, so that Arizona will be able to meet section 177's two-year lead-time requirement for imposition of the procedures in model year 2005.

IDLING RESTRICTIONS

Comment:
Eight comments were received suggesting that diesel idling restrictions be implemented.

Response:
This measure was approved by the Summit and the Summit thanks you for your interest.

Comment:
The IdleAire Technology Corporation (865-342-3600) sent a thirteen page report describing their product, an external heating, ventilation, air conditioning and A/C connections unit for use by idling lay-over diesel trucks at truck stops. Their report detailed the projected emission reductions that would occur if it was mandatory that their units be used at truck stops in Area A.

Response:
The emission, vehicle miles traveled, and truck stop layover survey information contained in the IdleAire report are accurate and point out that idle emissions could be reduced through a government-mandated idle restriction for lay-over trucks with the installation of this air conditioning/heating/electronic hook-up equipment at truck stops. This technology requires further examination.

Comment:
Two comments were received against the implementation of diesel idling restrictions.

Response:
The diesel idling restrictions measure proposed by the Summit does include exemptions for vehicles, like cement trucks, that need to be left idling for extended periods of time as part of their operation.

Comment:
Three comments were received suggesting that car idling restrictions be implemented.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
One commenter suggested that local truck terminals be eliminated.

Response:
A similar measure to restrict the building of truck terminals in Area A was proposed by Maricopa County to the Summit. The Summit rejected this measure.

Comment:
One commenter suggested that taxes on local vehicles used for delivery or transporting material be raised.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
More specific information should be supplied that describes the exact restrictions that would be imposed.

Response:
Those details are still being discussed with people who have an understanding of what will and will not work. If more details are available as the Final Report is adopted, they will be included in it.

NEW TECHNOLOGY

Comment:
One commenter relayed the following information: On one occasion we had a rain on Friday night. And behold the brown cloud was gone most of the weekend. This suggests the obvious! The exhaust gas components that give rise to your brown cloud are soluble in water. This includes all exhaust gases and particulates generated by oil, gas, and diesel motors plus other fixed sources. Thus, if this cloud is to be eliminated in the face of ever increasing mobile and stationary sources, one must attack it at its source and not after it gets into the atmosphere. This can best be done by a filter that uses steam to absorb the pollution elements causing the brown cloud. At the end of this filter, the pollution elements absorbed would be condensed and allowed to drip as a liquid on the pavement where the water would evaporate or flow into a sewer or ditch. In this way the brown cloud producing elements would be eliminated from the atmosphere. I am currently in the process of designing a filter of this type that is mounted downstream from the current catalytic converter unit.

In a separate e-mail, the same commenter relayed the following: What is needed is another active filter down stream from the catalytic converter unit now in use. One must transfer the chemicals and particles of the combustion process that now feed thru the exhaust filtering system to a liquid storage system on-board

the vehicle. When the vehicle takes on more fuel, the liquid with stored air pollution producing products in it would be transferred to the local sewer system.

Response:
Although rain and storm systems do clean the air, they do so through a combination of increased winds and wash-out by rain drops. The secondary pollutants of ammonium sulfate and ammonium nitrate, as well as the trace metal ions and their compounds, are indeed water soluble. However, most of the exhaust particulate – from gasoline and diesel engines alike – is elemental and organic carbon, both sparingly soluble in water. Steam injection probably enhances their solubility, but the engineering of such a control device to capture these water-insoluble particles will be a challenge. The disposal of the residue from such a control device presents another problem: it would have to be contained on the vehicle and periodically disposed of as if it were a hazardous waste, which it undoubtedly would be.

Comment:
One person suggested “PM remediation technologies” be evaluated and that several designs come to mind which could be prototyped on a small scale and evaluated for very little money. For example, how about a front car license plate that doubled as an electrostatic cleaner? While driving, such a

device would be ideally positioned, sweeping particulate emissions from a very high density zone: the exhaust plume of cars on Phoenix highways. Another logical placement in cars would the air intake vent. Such a device would collect important data about human exposure to PM while driving *and* provide a direct health benefit to the driver and passengers. How about air deflectors mounted on cabs of large diesel trucks? That would be another ideal location.

Response:
License plates doubling as electrostatic cleaners, air filters in the intake vents, or air deflectors on the cabs of large diesel trucks could all become workable air pollution control devices. In addition to the entrepreneurial activities to bring these devices to market, considerable testing would have to be done to determine their efficiency. This kind of activity could be stimulated by the right kind of government incentive programs.

Comment:
One commenter suggested that a method be found for containing micro particles from rubber tire wear.

Response:
The Summit thanks the commenter for the suggestion. Dust from tire wear is a very small portion of the total amount of particulate matter emitted into the atmosphere. Any control measure that reduces dust from paved roads will also reduce the impact of tire wear particles (e.g., PM_{10} efficient street sweepers).

GENERAL TECHNICAL COMMENTS

Comment:
One commenter stated that after a review of documents developed by MECA (Manufacturers of Emissions Controls Association), EPA, and California Air Resources Board, and discussions with Dan Metzler of Energy and Environmental Analysis, Inc., it appears that stand-alone oxidation catalysts no longer yield significant PM reductions to a modern fleet. The commenter also stated that Oxidation catalysts address only the soluble organic fraction (SOF) of exhaust PM; as the SOF is reduced through new engine design, these devices by themselves become less effective.... The report should at least reflect the limited and conflicting information on this technology.

Response:
The language in the report consistently refers to “oxidation catalysts and/or particulate traps”. The Manufactures of Emissions Controls presentation (Baltimore, December 1999) and other literature suggest that the oxidation catalyst would be used in series with a particulate trap to maximize the reductions of both gaseous and particulate emissions. The language of the report reflects this joint use, and nowhere indicates that the oxidation catalysts be used alone.

Comment:
Appendix 1, Page 18, Paragraph 4 (Idling Restrictions), one commenter stated that most refrigerated semi-trucks have a separate cooling system that allows the trailer to stay cold. Therefore, many of these would not need to idle. The commenter added that the report assumes that idling of buses would be limited to 5 minutes as well and the Texas program limits idling time for buses to 30 minutes. The commenter suggests prior to the legislative session, it would be helpful to prepare a

more accurate set of assumptions.

Response:
Separate cooling systems are fine, but they have to be powered by something. In a more definitive study, the idling of truck engines alone, the consumption of fuel by independent cooling units, and more realistic idling times for buses would ideally all be accounted for.

Comment:
Appendix 1, page 18 (Idling Restrictions): The commenter stated that the emission reduction estimates assume that "Idling emissions and in-use emissions are about equal." And stated that this seems inconsistent with historic presentations on vehicle emissions that indicate that start up and acceleration emissions are much higher.

Response:
In equating the idling and driving emissions of HDDV, ADEQ based this equality on a recent California Air Resources Board report, which, since it is still in draft, cannot be cited directly. With this approximation, a net idling tonnage of 89 metric tons of fine particulate per year is calculated from the inventory total of 1182 tons per year. This figure compares rather well with an independent calculation of 56 tons per year, obtained by multiplying the number of registered vehicles (22,367) by the percentage that idle (95%), by an assumed idling time per day of 4 hours, by 0.03 grams of particulate per minute, and by the days per year and minutes per hour. Both figures are probably lower bounds, since neither accounts for any idling by vehicles registered out of the county. The point here is not to ignore the complexities of vehicular emissions in idling, acceleration, and driving under variable loads; but, rather, to employ a reasonable assumption, to evaluate a control strategy for which definitive survey data are not available.

Comment:
Appendix 3, ENSR report, page 5-10, Table 5.2: The commenter stated that the total percent of Nitrogen Oxide Emissions totals to 90.1 rather than 100.

Response:
The table has an error in the first line, "on-road gasoline-fueled vehicles". The percentage should have been 39.5, not 29.6. Table 1 below gives the tonnages and percentages of nitrogen oxides for these categories.

Table 1. Emissions from the 1994 base case PM10 inventory (MAG)

source category	NOx (units in metric tons per year)	Percentage
industrial	8,689	8.65
on-road gas	39,689	39.50
off-road gas	379	0.38
on-road diesel	17,800	17.71
off-road diesel	33,925	33.76
Total	100,483	100

Comment:

Appendix 1, page 2, 4th paragraph: The commenter stated that appendix 1 incorrectly states that the MAG projected emission inventory for 2006 uses "EPA's NONROAD emissions model for offroad emissions".

Response:
ADEQ acknowledges that MAG did not use the NONROAD model to estimate off-road emissions. Appendix 1 will be changed accordingly.

Comment:
Appendix 1, page 18: The commenter stated that the assumption that NOx and PM-2.5 emissions on a per hour basis from an idling HDDV and an in-use HDDV are approximately equal is not supported by air quality models. The commenter asked that the rationale for the assumption or discuss the uncertainty level introduced into the assessment of this measure resulting from this assumption.

Response:
HDDV idling and on-road emissions. In equating the idling and driving emissions of HDDV, ADEQ based this equality on a recent California Air Resources Board report, which, since it is still in draft, cannot be cited directly. With this approximation, a net idling tonnage of 89 metric tons of fine particulate per year is calculated from the inventory total of 1182 tons per year.. This figure compares rather well with an independent calculation of 56 tons per year, obtained by multiplying the number of registered vehicles (22,367) by the percentage that idle (95%), by an assumed idling time per day of 4 hours, by 0.03 grams of particulate per minute, and by the days per year and minutes per hour. Both figures are probably lower bounds, since neither accounts for any idling by vehicles registered out of the county. The point here is not to ignore the complexities of vehicular emissions in idling, acceleration, and driving under variable loads; but, rather, to employ a reasonable assumption, reasonable to the California Air Resources Board anyway, to evaluate a control strategy for which definitive survey data are not available.

Comment:
Appendix 3, general: The commenter asked that a copy of the electronic CMB files be forwarded to MAG to allow for a peer review of the analysis.

Response:
The Chemical Mass Balance files will be forwarded to MAG.

Comment:
Appendix 3, general: The commenter stated that applying an averaged EC:OC ratio from the Nothern Front Range Air Quality Study may not be representative of the actual Phoenix fleet at the time the visibility data was recorded.... The commenter requested an explanation of why other study data was not considered in the Brown Cloud Analysis.

Response:
As shown in the October 4, 2000 memorandum from Mike George to the Brown Cloud Summit's Inventory Technical Advisory Group Chairman Richard Hayslip, vehicular particulate emission data from six studies were examined to better understand the split between elemental and organic carbon in the exhaust emissions (See Table 1, references). These studies were all conducted with similar

sampling and analytical methods in 1994-1996 – the period of ambient air analysis on which the Phoenix source apportionment work was based. While all the usual caveats apply to these studies – limited number of vehicles, different ambient conditions, slightly different fuels, large vehicle-to-vehicle variability, the influence of a few outliers, and smoking versus non-smoking gasoline vehicles – they remain collectively the best source of speciated carbon exhaust data. What's particularly interesting is that when these elemental/organic ratios are applied to the mass emissions of fine particulate in the inventory, the split between the two kinds of carbon differs so widely from what's in the ambient air. Among other avenues to understand this mismatch between inventory and ambient speciated carbon is MAG's suggestion of a sensitivity analyses incorporating different elemental/organic carbon ratios for gasoline and diesel combustion in a Chemical Mass Balance/inventory analysis.

Comment:
Appendix 3, page 3-1: The commenter asked for an explanation why the scattering factor is less than expected.

Response:
Elemental carbon both scatters and absorbs light: its scattering coefficient is generally thought to be about 1.6 m^2/g; its absorption coefficient, about 8.3 to 11.5 m^2/g. For the absorption coefficient, the lower value is a theoretical calculation from the Phoenix Brown Cloud study based on size-segregated (Moudi) samples; the latter is empirically determined from ambient measurements for three of the four sites in this study. The combination of the two, light scattering and absorption for elemental carbon,
yields a light extinction efficiency of about 10 m^2/g. All source apportionment work in the Brown Cloud Summit assigned a light extinction efficiency of about 10 m^2/g to elemental carbon.

Comment:
Appendix 3, page 4-2: The commenter asked for a comment on how the conservatively high estimate of the wood burning contribution may impact the source apportionment and visibility due to wood burning and vehicle emissions. The commenter also requested, if spring or fall data are available, why these data were not applied.

Response:
The contribution of wood burning to Phoenix fine particulate and visibility is low. Through source apportionment methods, wood-burning causes anywhere from zero to 10% of the fine mass, depending on the study, the site, and the season. If soluble potassium does over estimate its contribution, then this over estimation's overall effect on the source apportionment is small, simply because its contribution is small. Any number of additional chemical mass balance analyses could have been performed, including the spring and fall application of the soluble potassium component to other sources. This particular additional analysis was thought to be of only marginal benefit and was considered beyond the scope of this study. Should MAG and ADEQ technical staff agree that such an analysis, or perhaps, an attempt of a more refined analysis to pinpoint the contribution of woodburning, is worthwhile, then the work can proceed.

Comment:
Appendix 3, Page 4-4: The commenter requested an explanation of why the sum of the fractional contributions to geological materials was greater than one (Table 4-2). And asked for comments on

why other suggested approaches were not considered.

Response:
Reconstructing fine mass from the chemical concentrations of particulates always involves some approximations: the weighing, the analytical uncertainties, and the ignorance about precisely which chemical compounds are present. The Sisler and Malm method and the normalizing of the reconstructed concentration with the ratio of the measured to reconstructed total mass both have their advantages. The approach followed in the Brown Cloud Summit -- the calculation of the other fine mass as the difference between the principal ions and carbon and the total, with corrections for oxygen and hydrogen -- has been widely used in the source apportionment community and is adequate for urban source apportionments such as Phoenix, despite the occasional negative values encountered.

GENERAL COMMENTS

Comment:
Two commenters suggested that the report did not take a stand.

Response:
The purpose of the Brown Cloud Summit report is to provide the Legislature with options for reducing the brown cloud.

Comment:
Six comments were received suggesting that cars and trucks cause pollution.

Response:
Yes, cars and trucks are the biggest contributors to the brown cloud.

Comment:
One commenter was concerned about where funding for initiatives will come from.

Response:
Sources of funding for the initiatives will be determined by the Legislature.

Comment:
The report states the dirtiest days are in fall and winter. Could this be because of all the part-time people coming into Arizona with their huge motor homes? It seems that the air in the spring and summer is cleaner because there are higher winds in the spring to blow out some of the “brown cloud” and the snowbirds are gone.

Response:
In estimating how much pollution is emitted into the atmosphere, seasonal variability is considered, including the number of miles driven in each season, which reflects the activities of seasonal visitors. In general, there is not a significant difference in emissions from season to season even considering factors like winter visitors; however, there is substantial variability in weather. The stability of the atmosphere in fall and winter leads to pollutants being contained in a smaller volume of air near the surface as compared to spring and summer, which enjoy more frequent flushing of

the Valley. These differences in weather conditions are the primary reasons for seasonal variation. The Summit wanted to try to identify strategies that would be effective during poor visibility conditions, and thus best address the Brown Cloud.

Comment:
One commenter suggested there are “islands” within the County that contain gross polluters and these sources should be moved 35 miles away from the Valley and have emission controls enacted on them.

Response:
The Summit assumes the commenter is referring to stationary sources located throughout the Valley. Rules adopted by Maricopa County mandate that stationary sources must have permits before they are constructed or operated, no matter where they are located. A source’s permit contains limits for pollutants emitted by the source; if the limits are exceeded, the source is subject to enforcement action. The siting of a source is a local issue, based on local zoning determinations.

Comment:
One commenter stressed that the “issue” be addressed at a Valley level and not done in segmented tasks.

A second commenter suggested that a brown cloud hot line similar to the polluter (smoking vehicle) hot line be initiated to allow citizens to report polluters.

Response:
The Summit recognizes that success depends on the efforts of individuals, businesses, and industries located throughout the Valley and Maricopa County. In its analysis of the potential control measures, current and anticipated populated areas were considered to help determine where the measures would be the most effective.

The Maricopa County Environmental Response and Complaint Line, at (602) 506-6616, addresses both smoking vehicles and other types of air pollution complaints.

Comment:
The State of Arizona uses diesel fueled back-up generators that are tested about once a week and that cause noise and air pollution to the surrounding neighborhoods. The State should be a model citizen, and switch to some other type of generator, if it expects to get voluntary cooperation from private enterprise.

Response:
The Summit's Draft Final Report makes no recommendations for control measures for diesel fueled backup generators. The Stationary and Area Source Subcommittee did extensive research of control measures implemented by other states for stationary internal combustion engines. Most of these were centered around designation of the types of fuels and use of NOx emission controls. It is recognized that backup generators, both public and private, need to be maintained and tested on a regular basis in order to maintain their state of readiness. The Brown Cloud Summit did not recommend switching the types of generators used, it discussed potential control measures including limiting the fuel used to only low sulfur diesel to reduce emissions, which is already required by Arizona Statute.

Comment:
One person suggests formulating an Arizona Quality of Life Mission and Goals, along with an analysis of items which adversely affect our quality of life, and with recommendations to move toward this Mission.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
One person suggests installing "scrubber technology" similar to power plant scrubbers in the median areas of the major freeways to clean the air along the freeways.

Response:
Scrubber technology is generally most effective when installed in applied to stack with a confined gas steam or within an enclosed area where air movement is small. Attempting to abate automobile pollutants by placing scrubbers along freeways would require many expensive scrubbers and large air handling equipment, both requiring huge amounts of power to operate. The cost would likely be high and the efficiency of such a system is likely to be low because the automobile exhaust could escape the control system.

Comment:
One person asks why there has not been a stronger tax incentive and/or retail sell back cost for homeowner photovoltaic generator power? This would invite more homeowners to install solar cell panels on homes.

Response:
The goal of the Brown Cloud Summit is to reduce air pollutants that affect visibility. Source contribution from natural gas combustion (primarily used in residential heat) contribute a small portion of the pollutants causing the haze (about 1-2%). This is compared to gasoline and diesel combustion that generate about 50-60% of the urban haze pollutants. The Brown Cloud Summit focused mainly on reductions of emissions from use of vehicles. While solar power for Arizona has many virtues, it would be a result in very small improvement to the brown cloud.

Comment:
One person suggested that if the State is going to do a lawn mower buyback program, the managing board should include an individual who is in the Outdoor Power Equipment industry. Such a person would be able to help set up the program with dealers and purchasing of equipment. In addition, it was suggested that an engine buyback program could be initiated as sometimes only the engine needs replaced.

Response:
Legislative funding for the lawn and garden equipment buyback program implemented by the Maricopa County Environmental Services has been utilized for the current fiscal year. If the Legislature does fund it for future years, the suggestions could be considered as program components.

Comment:
One commenter suggests requiring vapor capture/recovery systems on all gas station pumps.

Response:
Federal regulations require vapor recovery systems in gas stations that dispense more than 10,000 gallons of gasoline per month as a control measure to reduce VOC's, which are precursors to ozone formation.

Comment:
One person suggests pollution from the Indian Reservation to the north of Mesa is not directly controllable and we need to stop sending our waste there.

Response:
Although solid waste is an important issue, the Brown Cloud Summit's charge did not include solid waste.

Comment:
One person suggests encouraging stores to close one day per week, probably Sunday, to reduce automobile traffic.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
One commenter indicated that the AZ Community Tree Council in Phoenix can provide statistics and have programs in place to promote the planting, planning and maintenance of trees in the low desert.

Response:
The Summit thanks the commenter for the information.

Comment:
One person asked what is WRAP and MAG?

Response:
WRAP is the acronym for the Western Regional Air Partnership (http://www.wrapair.org). WRAP is a collaborative effort of western states, tribes and federal agencies to promote and monitor implementation of recommendations from the Grand Canyon Visibility Transport Commission. State participants are Washington, Oregon, Idaho, Montana, Wyoming, North Dakota, South Dakota, California, Utah, Colorado, Arizona and New Mexico. Tribal nations include Pueblo of Acoma, Campo Band of Kumeyaay Indians, Cortina Indian Rancheria, Hopi Tribe, Hualapai Nation of the Grand Canyon, Jicarilla Apache Tribe, Northern Cheyenne Tribe, Salish and Kootenai Confederated Tribes, Pueblo of San Felipe, and Shoshone-Bannock Tribes of Fort Hall. Representatives of other tribes participate on WRAP forums and committees. Federal participants are the Department of the Interior, the Department of Agriculture, and the Environmental Protection Agency.

MAG is the acronym for the Maricopa Association of Governments. MAG is a voluntary association that serves as a regional planning agency for the metropolitan Phoenix area. The MAG membership currently consists of the 24 incorporated cities and towns within Maricopa County, the Gila River Indian Community, the Salt River Pima Maricopa Indian Community, Maricopa County,

the Arizona Department of Transportation (ADOT) and the Citizens Transportation Oversight Committee (CTOC). ADOT serves as an ex-officio member for transportation-related issues. MAG provides a regional forum for analysis, discussion and resolution of issues including areas of transportation, air quality, environment, regional development and social services. Its many responsibilities include regional transportation and air quality planning.

Comment:
One commenter asked that the Summit consider the effect of "chemtrails" on the brown cloud.

Response:
While numerous theories exist regarding "chemtrails," the Summit did not address these issues because these are contrails, visible trails of water droplets or ice crystals sometimes seen in the wake of high-altitude aircraft. There is no evidence linking them with poor visibility conditions in the Valley.

Comment:
Two commenters suggested solar-powered windmills or fan towers such as those located in California be placed on the west edge of the Valley to move the "brown cloud" out of the Valley and into an area where stronger winds would break it apart. The towers could be leased as cell phone, telephone and broadcast relay stations and generate electricity as a by-product which sold to the utility companies provide funds for the state's general revenue fund. These funds could then be spent for health care, education, or environmental issues. Another person suggested incentives be provided for the use of solar power.

Response:
With respect to the feasibility of this suggestion, the Salt River Valley is hampered by what is one of the weakest wind fields of any metropolitan area in the United States. By "weak wind field" is meant lower than average wind speeds. Coupled with a population of three million people, this weak wind field and the strong nighttime surface temperature inversions of the clear-skied, arid climate combine to produce high concentrations of air pollutants and low visibility. To significantly enhance the horizontal movement of the surface layer air throughout the Valley, an extensive array of wind mills would be needed, perhaps as many as one every one eighth to one quarter a mile. ADEQ knows of no successful application for enhancing ventilation throughout a broad area; the towers in California are used primarily to generate power, not reduce pollution.

Comment:
One commenter suggests each rooftop in this Valley can be made of solar paneling to provide power for each domicile.

Response:
The goal of the Brown Cloud Summit is to recommend strategies to reduce air pollutants that affect visibility. Source contribution from natural gas combustion (primarily used in residential heat) contribute a small portion of the pollutants causing the haze (about 1-2%). This is compared to gasoline and diesel combustion that generate about 50-60% of the urban haze pollutants. The Brown Cloud Summit focused mainly on reductions of emissions from use of vehicles. While solar heating for Arizona was many virtues, it would result in a very small improvement to the brown cloud.

Comment:
One commenter asked if each item been implemented in other communities and what were the actual economic and results (by item)?

Response:
One of the charges from the Governor was that the Summit review measures that would improve urban visibility that were under consideration or currently implemented in other states. Each measure was also to be evaluated for cost effectiveness. The Subcommittee final reports provides more background on each control measure, the measure's origin, other states implementing a similar measure and the cost of the measure.

Comment:
One commenter asked about the length of time it takes to complete freeways and suggests that sections at a time be opened. The commenter also indicated that road construction is a constant problem and suggested that construction be done during less peak months?

Response:
Inquiries regarding freeway construction schedules should be directed to Arizona Department of Transportation email: info@dot.state.az.us.

Comment:
One commenter indicated that the State of Arizona uses diesel fueled back-up generators that are tested about once a week and that cause noise and air pollution to the surrounding neighborhoods. The commenter suggested the State should be a model citizen, and switch to some other type of generator, if it expects to get voluntary cooperation from private enterprise.

Response:
The Summit's Draft Final Report makes no recommendations for control measures for diesel fueled backup generators. The Stationary and Area Source Subcommittee did extensive research of control measures implemented by other states for stationary internal combustion engines. Most of these were centered around designation of the types of fuels and use of NOx emission controls. It is recognized that backup generators, both public and private, need to be maintained and tested on a regular basis in order to maintain their state of readiness. The Brown Cloud Summit did not recommend switching the types of generators used, it discussed potential control measures including limiting the fuel used to only low sulfur diesel to reduce emissions, which is already required by Arizona Statute.

Comment:
One commenter suggests expanding to other cities in Arizona.

Response:
The visibility measurements show that the brown cloud problem is more pronounced in the Phoenix area than elsewhere in the State, so it was targeted initially. That is not to say that urban visibility might not be addressed in other parts of the State in the future.

Comment:
One person suggests contests with benefits/rewards to major businesses who pollute the least.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
One commenter had the following comments regarding measures considered but not recommended:

- They encourage the Summit to include "Just in Time Clearing for Construction Projects" (the measure indicates that the barrier to implementation is cost of additional county staff)
- They concur with not recommending the "Dust Palliative Incentive"
- They discourage "Transfer of State Authority for Portable Sources to the Counties"
- And they requested additional information on "Additional Emission Reductions from Consumer Products".

Response:
With regard to "Just in Time Clearing for Construction Projects" the Stationary and Area Source Subcommittee determined that increased enforcement for Maricopa County Rule 310 from additional funding could address this potential control measure. Therefore, the Subcommittee removed this measure from the list of potential control measures during its October 6, 2000, meeting.

Information regarding the "Additional Emission Reductions from Consumer Products" measure was presented at the September 13, 2000, meeting of the Stationary and Area Source Subcommittee in a draft document entitled "Draft Strawman Compilation of Possible Near-Term Control Strategies for Urban Haze in the Phoenix Metropolitan Area" on page 8. The description of the measure was as follows:

> Consumer products represent approximately 5.6 percent of the Maricopa County Ozone Nonattainment Area emission inventory for VOCs. Currently, Maricopa County Rule 344, Automotive Windshield Wiper Fluid, addresses only 5-6% of the consumer products emissions. The California Air Resources Board (CARB) has developed a more comprehensive set of consumer product regulations, including the Antiperspirant and Deodorant Regulation, Phase I & II Consumer Products Regulation, Alternative Control Plan Regulation, and its Aerosol Coating Regulation. CARB estimates that these regulations will reduce emissions from consumer products by 30 percent. The Task Force recommended adoption of California consumer products regulations.
>
> State law would need to be amended to provide ADEQ the authority to implement rules paralleling the applicable CARB measures. One year to 18 months would be required once program authority is clarified in the state statute to complete the rule adoption process. Approximately one year after rule adoption, products would be required to meet limits established in the rules.
>
> Implementation of the CARB consumer products program is estimated to reduce VOC emission an additional 5 percent or 1 ton per day of VOC emission reduction. Sierra Research (1993) estimated the cost effectiveness to be $1,598 per ton. This cost includes 1.5 FTE for administration, enforcement and laboratory or $100,000 per year.

Comment:
One commenter asked the following two-fold question: Was subsidized parking for state, county, and city employees that carpool considered? And was providing incentives to private employers for alternate modes such as carpooling and bus riding on a frequent basis considered?

Response:
The Brown Cloud Summit did not consider such measures, although they are included in current programs.

Comment:
Two comments were received suggesting that drivers be educated or advertisements be made of the contribution of driving to air pollution.

Response:
A primary function of the local Regional Travel Planning Authority's (RTPA) is to educate drivers and advertise the contribution of driving to air pollution.. For more information, please visit the following Web sites: http://www.valleymetro.maricopa.gov/ and www.dot.state.az.us/about/transit.

Comment:
One commenter suggested that state employees be allowed to take state cars home before road trips.

Response:
State employees are allowed to take state cars home before road trips with their supervisor's approval.

Comment:
One commenter suggested that inflating vehicle tires to maximum pressure be promoted to increase gas mileage and decrease emissions. In addition, that incentives be offered for purchase of vehicle tires with low rolling resistance.

Response:
Vehicular emissions may be reduced by tires with the optimal inflation or with low rolling resistance, although no studies are available to quantify these reductions. Except for those vehicles with grossly under inflated tires, however, the benefits per vehicle would be minimal. Still, proper inflation for better gas mileage and perhaps slightly lower emissions a is good practice, as would be encouraging the purchase of low-resistance tires.

Comment:
Eighteen comments were received suggesting that growth restrictions / higher population density (also infilling), responsible urban planning (e.g., neighborhood-based work sites) be implemented.

Response:
There is no question that the Valley is one of the fastest growing areas of the country and this growth has been a concern for some time. Expected continued growth is one reason the Summit is recommending that two additional monitoring sites be situated in the east and west parts of the Valley to help assess the effect of growth and appropriate application of control measures. Growth does not need to be an enemy of environmental quality. In fact, if the economy doesn't grow, there are no tools in place to deal with environmental issues as they arise.

The Summit did not consider recommending measures such as freezes on building permits or impact fees.

Comment:
One commenter relayed the following information: In the early 1960's, a man by the name of Ferrell Bailey invented a device which when attached t a regular combustion engine did in fact and this is documented reduced pollutants by 99.9% on every vehicle it was attached to. As a result of this it also tripled gas mileage. Then this man's lawyer had him sign a document giving up his legal rights to this device to a large oil company. As a result of this we now have the catalytic converter, and I know this to be a fact because I have access to documents (specs and blueprints) of the device. So my comment to this problem is if you'd stop letting the oil companies run our country we wouldn't have this problem.

Response:
The Summit thanks the commenter for the suggestion.

Comment:
Nature Volume 408, Number 6813, Page 631, Dec. 7, 2000 indicates a scientific link between childhood asthma and 160 foot proximity to busy roads. Will Arizona face a similar situation in the future?

Response:
Concentrations of vehicular air pollutants are highest in those parts of the city that are (1) close to busy roadways, and (2) within the highest general concentration zones in the urban area. From monitoring of fine particulates in metropolitan Phoenix, it's clear that the concentrations of fine particulates are highest in the west-central area, taper off to about two thirds of this areal maximum in the outlying areas, and decrease to about one third of the central-city maximum in background areas outside the metropolitan area. It is precisely in these environments with high fine particulate concentrations that respiratorily sensitive individuals, including asthmatic children, are likely to experience difficulties. As emergency room doctors and the Arizona Lung Association can attest, the exacerbation of respiratory health difficulties by local and regional air pollution has been and continues to be a significant health problem. All of the control measures endorsed by the Brown Cloud Summit would reduce the concentrations of these fine particulates and consequently, improve the respiratory health of the citizenry.

Comment:
What are other high density / traffic metropolitan areas doing to decrease urban traffic and increase commuter awareness of available options?

Response:
Before the Brown Cloud Summit convened, a literature review was conducted to determine what measures other metropolitan areas were using to improve visibility. This review included reports from the Governor's Air Quality Strategies Task Force (Arizona); Clark County / Las Vegas, Nevada; Portland, Oregon; Seattle/Puget Sound, Washington; Washoe County/Reno, Nevada; South Coast Air Quality Management District, California; State and Territorial Air Pollution Program Administrators/Association of Local Air Pollution Control Officials; Grand Canyon Visibility Transport Commission; San Francisco, California; and Texas Natural Resource Conservation Commission. These measures focused on reducing emissions originating at the source

rather than reducing urban traffic. However, Phoenix metropolitan voters did approve additional funding for expansion of the bus system and building of a light rail line – the same actions used by other metropolitan areas for reducing urban traffic.

Comment:
How long until these measures are implemented?

Response:
Some control measures are designed to be implemented in the near-term (beginning 2002 or 2003), while others are more long-term. Please refer to the subcommittee reports for more details on each proposed control measure. In the end, implementation of most of the Summits' proposed measures will be contingent upon adoption of the measures by the Legislature and the time schedules they select.

Comment:
I would like to learn what percentage of vehicles, which are tested, actually do fail and are taken off the road. Is there a web site where I could see such data? Have any government statisticians ever figured out how much productivity is wasted just waiting in lines for the test? I have learned that alternate non-invasive methods/technology to detect the faulty vehicles is available. Why is it not used instead?

Response:
The following results were obtained from a detailed evaluation of the vehicle emissions inspections program conducted in 1999:

1. About 11% of light-duty gasoline vehicles of model year 1981 and newer fail their initial inspection.

   About 37% of light-duty gasoline vehicles of model year 1980 and older and heavy-duty gasoline vehicles of all model years fail their initial idle/loaded test.

   About 30% of these vehicles which fail their initial test "disappear" from the system; that is to say that they do not either pass the test or are given a waiver. While some may leave the area, get junked, or are driven without valid registrations, the actual fate of these vehicles is uncertain.

Winston Harrington and others of Resources for the Future, in a July 1999 paper entitled "Are Vehicle Emission Inspection Programs Living Up to Expectations?," have estimated the average annual costs per vehicle (for all vehicles, passing and failing) for travel and waiting time to be a little over $5.00.

2. The alternative, non-invasive methods fall into the category of "remote sensing" programs. Such a program was carried out in metropolitan Phoenix for about three years, ending in May 2000 through legislative direction. The Arizona experience with remote sensing has been checkered. The technology is still in development and suffers from numerous limitations, among them, accurately identifying vehicles that are truly malfunctioning. In addition, a large number of people owning vehicles cited for being high emitters failed to comply with the requirement to have their vehicles repaired and tested. These problems led

the legislature to cancel the program and direct the Department of explore some more effective alternatives. Even with the advent of on-board diagnostic systems, which warn the driver when unacceptably high emissions are occurring, without an inspection test, the driver would still have the option of disregarding the warning. Requiring vehicles to have a periodic emissions test -- even considering the cost, the inconvenience, and the imperfections -- remains a corner stone of urban air pollution control. Virtually no other measures to reduce pollution are as effective and cost-effective.

Comment:
As we go to work (carpool) we see vehicles that spew pollution on a regular basis. Do you have ways of knowing if all vehicles go for emissions tests?

Response:
There is a way to determine if a vehicle has complied with emissions testing requirements. Since the late 1980's, the sticker on the license plate that identifies the expiration date of the registration for that vehicle has been in different colors, depending on whether the vehicle went through emissions testing or not (e.g., if tested, the sticker might be white lettering on red background; if not, white lettering on a blue background). The “compliance sticker” colors for registrations that expire in 2001 are medium green lettering on a white background if the vehicle was ***not*** tested and white lettering on a medium green background if the vehicle was tested. For registrations that expire in 2002, black lettering on yellow background for vehicles ***not*** tested, and the reverse for those that have been.

Comment:
Are there any plans to start a bus line on Chandler Blvd (west of I-10) that would connect with the Intel facility?

Response:
Please contact your local city government’s bus department for plans to expand bus routes or to recommend expansion of bus service (see phone listing under “Bus”, Government Pages, Business White Pages).

Comment:
I heard that the Federal Government is requiring clean burning fuels for trucks and buses by 2007. Is Arizona going to meet that date, or will it be done sooner?

Response:
It is anticipated that if the Legislature adopts the clean burning diesel measure, that implementation would occur as soon as it would be feasible for oil companies to supply adequate volumes of this fuel to Maricopa County.

Comment:
Would you explain to me why we are paying more for diesel than premium unleaded gas?

Response:
The U.S. Department of Energy, Energy Information Administration distributes a wealth of information regarding the prices of fuels, including analyses of extraordinary market conditions. Their Web site is www.eia.doe.gov.

Comment:
Just outside Area A, in Casa Grande, is a major OTR truck refueling center, which will not have to carry CARB diesel; many westbound trucks will no doubt refuel there. Was this taken into account when computing the cost-effectiveness?

Response:
Yes. It was assumed that only 28% of the diesel miles would be driven by vehicles using CARB diesel.

Comment:
With respect to CARB diesel, does the Visibility Assessment Tool Results include the benefits of reduction in HC, CO and SOx? If not, this should be highlighted.

Response:
The Brown Cloud Assessment Tool only provides estimates for pollutants that may affect visibility. As such, CO, which is neither visible nor a PM precursor, is not modeled. Any assessment that includes a quantification of CO emissions reductions would have come from another sources, which should have been cited within the report.

Comment:
An explanation of GVWR is necessary.

Response:
The acronym means gross vehicle weight rate. *The text of the report will be revised to clarify the meaning of the acronym.*

Comment:
One commenter suggested that the description for Mandatory Adoption of CARB Diesel in Appendix 1 mention that CARB Diesel was one of the measures recommended in the MAG Brown Cloud Study of 1999.

Response:
The text of Appendix 1 will be modified to reflect this.

Comment:
One commenter provided the following comments regarding the evaluation of the visibility impacts of CARB diesel:

1. The vehicle miles traveled (VMT) data for diesel vehicles used was not supplied by MAG. The MAG estimate of diesel VMT is 4.440 million per average annual day in 1998 for the PM-10 nonattainment area. The analysis does not include light-duty diesel vehicles or trucks and may include heavy-duty gasoline powered vehicles or trucks.

2. What was the source for the assumption that 15 percent value used. In addition, please clarify that this value represents diesel trips with one end of the trip in Maricopa County by vehicles which are not registered in Maricopa County.

3. Will the reanalysis presented to the Brown Cloud Summit on December 12, 2000, be

reflected in the final report.

Response:

1. The following discussion relates to an analysis presented to the On-Road Mobile Sources Subcommittee on November 2, 2000, regarding the amount of diesel traffic that would be operating on locally purchased diesel fuel. Earlier analyses of the potential impact of CARB diesel on area diesel emissions presumed that 85% of the diesel VMT in the area were by vehicles that were operating on locally purchased diesel fuel. This presumption was considered reasonable, but not backed by any research or data. ADEQ met with a representative of the trucking industry to develop an analysis that would provide a new assumption backed-up by data. The analysis presented to the Subcommittee determined that 28% of the local diesel traffic would be operating on locally purchased fuel, and thus, the evaluation of the impact of CARB diesel on visibility would affect 28% of the total on-road diesel emissions.

   It was not discovered until early December that a number of flaws existed in the analysis conducted to assess the actual local diesel fuel demand. ADEQ erred in that the origin of the vehicle miles traveled data was the ADOT Highway Performance Monitoring System and not Maricopa Association of Governments (MAG). Further, the ADOT data were for all heavy duty vehicles, not just diesel vehicles. This resulted in underestimation of the visibility improvements from the on-road use of CARB diesel, because the ADOT VMT estimate is 89% greater than the MAG estimate. Additionally, if the data used by ADEQ in the analysis are taken at face value, an average of 2 to 3 long-haul trucks per second (over a 24-hour period) would be entering or leaving the Valley on each of the five major ingresses and egresses (U.S. Rt. 60, I-10 and I-17). If the MAG estimate is used, the average is closer to 1 long-haul truck per second. *Appendix 1 will be modified to reflect the MAG VMT numbers for this control measure.*

2. The estimate that approximately 15% of the trucks with either an origin or a destination in the Phoenix area would be refueling in the area with CARB diesel was derived as a "reasonable"

   assumption. Because diesel fuel would be more expensive, that would serve as a deterrent to local refueling by long-haul trucks, but would not eliminate it.

3. The information presented to the Summit on December 12, 2000, was completely consistent with the Draft Report and supporting documents and analyses.

Comment:

One commenter questioned why there was no estimate of capital costs for two control measures: Voluntary Early Implementation of Ultra-Low Sulfur Diesel Fuel for Use in Retrofitted Diesel Vehicles, and Clean Fleets and Equipment Incentives.

Response:

The research that calculated the costs of this control measure provided a single cost-per-gallon for the fuel and the retrofits. Because all of the costs associated with capital improvements would not accrue for the investments in the retrofitted vehicles (e.g., property tax and increased insurance costs), it was considered appropriate to identify all costs under the category of operations and

maintenance.

Comment:
Had we not performed emissions testing, what percentage improvement would have been realized simply as a result of manufacturers' improvements and recycling of the total vehicle fleet, over the same time period?

Response:
How much improvement in air quality can be attributed to various control programs sheds some light on their relative benefits. In Maricopa County, three major vehicular emission control programs have been in operation: the Federal new vehicle emission standards (1968), the State Vehicle Inspection and Maintenance program (1976), and the State oxygenated fuels program for winter gasoline (1989). Looking at ambient concentrations of carbon monoxide in Phoenix through 1990, and figuring the emission reductions with the standard models, the improvement in the ambient air quality at that time broke down as follows:

Federal new vehicle emission standards	76%
State oxygenated fuels for winter	16%
State Vehicle Inspection & Maintenance	8%.

The turn-over of the fleet is incorporated into the federal emission standards.

Unfortunately, a more current evaluation of the effects of all of these pollution control programs is not available. However, since 1990, vehicle emission standards have not changed much, while gasoline has been substantially modified to further reduce emissions, and the Inspection and Maintenance program has become more stringent, and, therefore, more effective.

The purpose of the State Vehicle Inspection and Maintenance program is to encourage vehicle owners to maintain their vehicles to meet the federal emissions standards and to identify vehicles that no longer meet the federal standards and affect their repair. Note that when a late model vehicle modern pollution controls falls into disrepair, it is possible for its emissions to be higher than a well-maintained older vehicle with no pollution controls. As such, these two programs work together.

Comment:
When is a test facility going to be built in Pinal County?

Response:
The siting of an emissions testing facility in Pinal County is currently under review by ADEQ and the vehicle emissions inspections contractor. An additional testing facility is expected to be built in the far east Valley, but its exact location has not been determined.

Comment:
One commenter asked about the adjustment of growth rates, which was discussed in the Brown Cloud Assessment Tool (BCAT) Users Guide (page 2-7).

Response:
An example calculation and clarifying language will be added to the text. The Users Guide will be available on the ADEQ Web site at http://www.adeq.state.az.us

Comment:
One commenter asked about the effect of increased PM-2.5 control efficiencies on coarse material, which was discussed in the Brown Cloud Assessment Tool (BCAT) Users Guide (Tab 2.3.4).

Response:
An example calculation and clarifying language will be added to the text. The Users Guide will be available on the ADEQ Web site at http://www.adeq.state.az.us

Comment:
One commenter asked about the derivation of transfer coefficients, which was discussed in the Brown Cloud Assessment Tool (BCAT) Users Guide (page 3-8).

Response:
An explanation of the speciated-rollback methodology and a specific example will be added to the text. The Users Guide will be available on the ADEQ Web site at http://www.adeq.state.az.us

Comment:
One commenter recommended that the following terms be added to the Glossary to assist in reading the Appendices to the report: aerosol, ammonia, carbon, fugitive, high emitting or gross polluters, heavy duty, light-duty, and VMT.

Response:
The Glossary in Appendix 6 will be amended to reflect the inclusion of the additional terms.

Comment:
One commenter asked that "Appendices Volume One" be deleted from the Revised MAG 1999 Particulate Plan reference in Appendix 5.

Response:
Appendix 5 will be amended to reflect the requested deletion.

Comment:
One commenter asked that "(16 pages)" be deleted from the MAG 1999 Brown Cloud Report reference in Appendix 5.

Response:
Appendix 5 will be amended to reflect the requested deletion.

Comment:
One commenter asked that the October 1999 Draft Brown Cloud Report be deleted from the list entirely.

Response:
Appendix 5 will be amended to reflect the requested deletion.

Comment:
Appendix 1, Page 14, Paragraph 1 (Roadside Diesel Testing). One commenter suggested adding a verb in the second sentence. Add “is” after ADEQ.

Response:
Appendix 1 will be amended to reflect the requested addition.

Comment:
Appendix 1, Page 14, Paragraph 1 (Roadside Diesel Testing). One commenter suggested adding a sentence to indicate why this program would be dropped in 2006.

Response:
Appendix 1 will be amended to clarify that the program will be sunset in 2006 in order to reevaluate the program’s effectiveness.

WSPA Minority Report
To The Governor's Brown Cloud Summit
January 2001

The enclosed represents a minority report, on behalf of the Western States Petroleum Association (WSPA), with respect to specific technical aspects of Governor Hull's Brown Cloud Summit convened in the year 2000. WSPA is a trade association representing approximately thirty oil companies involved in the exploration, production, refining and marketing of petroleum and petroleum products in the six western states. Since a major focus from the start of the Brown Cloud Summit was on a subject of significant interest to our industry; diesel fuel reformulation, WSPA and it's companies have participated extensively in the Summit deliberations of how to cost-effectively improve visibility in the greater Phoenix area. During the Summit process, there were a number of technical issues that arose, some of which our members felt obligated to record in a minority report

The WSPA minority report addresses the following issues:

- **Inventory Technical Advisory Group (ITAG) Model/Tool**
- **Emission Credit Trading Programs,** and
- **Health Effects**

I. Inventory Technical Advisory Group (ITAG) Model/Tool

The ITAG model, which was used to assess potential control measures, is fundamentally flawed. Its use may result in the selection of control measures that will worsen visibility in the Phoenix area. Attachment I includes our detailed comments with respect to the ITAG assessment tool, the emissions inventory adjustment for organic and elemental carbon, and the use of mobile source model estimates for ambient PM sulfate and nitrate production.

II. Emission Credit Trading Programs

WSPA believes that a thorough study should be conducted of the benefits/risks of a voluntary Emissions Credit Trading Program that was proposed at the end of the Summit's deliberations. Such credit banking and trading programs, if properly designed and implemented, MAY provide flexibility and improved cost-effectiveness in the process of achieving air quality improvement. However, while emission reduction credit trading programs represent what may be an appealing market-based alternative to command and control programs, they must be carefully implemented in order to assure that they achieve real emission reductions and improvements in air quality without causing adverse economic impacts on either the sources subject to the program or on the governmental agencies responsible for operating the program.

There are a number of complex issues that require detailed discussion such as: pollutants(s) which are applicable, emission reduction targets and air quality goals, as well as the types of sources to be

included in a program. In particular, the inclusion of mobile sources in a credit trading program will likely be problematic.

WSPA therefore supports the formation of a board or other entity to first assess whether the benefits outweigh the risks, and whether this kind of program is appropriate for Phoenix and it's air quality goals. Only after this assessment is done should the design and implementation discussion take place. Obviously the Board should include representation from affected stakeholders. Appendix II summarizes WSPA's views on effective credit banking and trading programs and could serve as a starting point for discussion on the value of such a program to reducing the Brown Cloud in Phoenix.

III. Health Effects

Under "Health Effects" in the Brown Cloud draft report, the statement on estimated deaths attributed to air pollution appears as follows: "Applying the results of recent health studies to PM2.5 levels measured in the Valley, between 250 and 1,000 additional deaths in the Phoenix area each year are currently caused by PM2.5 air pollution." The reference to support this statement are comments provided by Arden Pope at the Brown Cloud Summit meeting on July 11, 2000.

This statement should be deleted. We do not believe that comments by one scientist at a meeting should be used as definitive proof for quantifying deaths from air pollution in Phoenix, or elsewhere. Before such values appear in a report of this magnitude, our view is that the risk figures should be subjected to scientific review and be ultimately based on a thorough review of the literature, including recent studies of effects of air pollution in Arizona.

Health effects from exposure to particulate matter (PM) are NOT definite and NOT easily quantifiable. In fact, there is much uncertainty in the health effects presented by ambient PM and quantification of the risks. For this reason, Congress mandated and has funded for the last 3 years a comprehensive research program to explore the health effects of PM. The total cost of the 10-year program, outlined by the National Academy of Sciences, is estimated at approximately $400 million.

Other key points with respect to the health effects issue are:

- The data on PM are less than consistent.
- The key study used by the USEPA in establishing its proposed 1997 fine particulate National Ambient Air Quality Standard (NAAQS) - the ACS study - was recently reanalyzed and the inclusion of a number of covariates, including sulfur dioxide, other gaseous pollutants, education level, population change, unemployment, number of hospital beds, temperature, temperature variation and altitude, reduced the estimated relative risk of PM.
- While it is estimated that between 40-60% of PM2.5 is derived from combustion sources, diesel exhaust PM is a relatively small source of the total ambient PM. The best estimate of population exposure to diesel PM is 1-2 ug/m^3 (CALEPA) or less than 10% of the ambient fine PM.
- The data with respect to combustion particles being likely to be carcinogenic are controversial and inconclusive in nature.
- We are aware of three studies of the effects of PM air pollution in Arizona:

1. In the first study, Shreffler et al. reported a small risk attributed to coarse particle exposure in Phoenix while no association was observed between fine PM mass and mortality. (Shreffler, J., Smith, R., Davis, J. (1997). An Initial Search for Association between Particulate Concentrations and Daily Mortality in Phoenix).
2. In a recently reported study, air pollution and daily mortality in Cook County IL, Los Angeles County CA, and Maricopa County AZ were investigated. In general, the author concluded that ambient gases were more important in mortality associations than PM and the recent emphasis on PM appears misguided. In Maricopa County there was no evidence of any association of particulate matter (PM10) with respiratory (COPD) mortality. (Moolgavkar, S. (2000). Air Pollution and Daily Mortality in Three U.S. Counties. Environmental Health Perspectives 108: 777-783).
3. In another recently reported study, the effects of air pollution on hospital admissions for diseases of the circulatory system in three U.S. metropolitan areas, including Maricopa County, were investigated. In Maricopa County, the gases, with the exception of ozone, were weakly associated with hospital admissions for cardiovascular disease, while no associations were observed for PM. (Moolgavkar, S. (2000). Air Pollution and Hospital Admissions for Diseases of the Circulatory System in Three U.S. Metropolitan Areas. Journal of the Air and Waste Management Association 50; 1199-1206).

- The USEPA's Clean Air Science Advisory Committee (CASAC) view is: (1) there is inadequate evidence to establish a causal relationship between exposure to diesel PM and cancer , and (2) the uncertainty in the diesel exhaust data make it impossible to derive, with any confidence, quantitative estimates of cancer risk.

Mr. Will Humble of the Arizona Department of Health Services (ADHS)/Office of Environmental Health made a PM health effects presentation to several of the Brown Cloud Summit subcommittees. Mr. Humble's presentation is inaccurate and misleading. It conveys that the health effects from exposure to particulate matter (PM) are definite and easily quantifiable. As we noted above, there is much uncertainty in the health effects presented by ambient PM and the quantification of the risks. Attachment III includes WSPA's detailed comments with respect to Mr. Humble's presentation.

ATTACHMENT I

Use Of a Modified Integrated Assessment System (IAS) To Estimate Visibility Impacts

A modified Integrated Assessment System (IAS) was used to evaluate Phoenix visibility improvement control strategies. The IAS was originally developed for the Grand Canyon Visibility Transport Commission (GCVTC) to evaluate the costs and benefits of emissions control strategies to improve western Class I area visibility. WSPA does not believe the modified IAS provides an accurate estimate of visibility impacts from proposed emission controls in Phoenix. The IAS was developed for regional applications where gaseous pollutants have time to mix and to be converted to particulate. The IAS system assumes that reductions in sulfur and nitrogen oxides will produce proportional reductions in aerosol sulfate and nitrate. Because of short transport times over the urban area and non-linear chemistry, this assumption is oversimplified and the modified IAS may significantly overestimate the impact of emission control strategies on Phoenix PM and visibility.

We believe photochemical-grid modeling, which uses state-of-the-science aerosol dynamics and chemistry, is the best science available to evaluate emissions reductions from a mix of control strategies. Unfortunately, grid modeling is more time and cost intensive than the selected modeling methodology.

The successor to the GCVTC, the Western Regional Air Partnership (WRAP), and the corresponding modeling subgroup--the Air Quality Modeling Forum (AQMF)--proposes to minimize further use of GCVTC transfer coefficients. It currently proposes to ultimately use a "one-atmosphere" comprehensive model—the EPA-developed MODELS3 regional scale grid model--to study emissions impacts on visibility in the western states. Unfortunately, MODELS3 for PM has not yet been satisfactorily developed.

The IAS was modified for the Phoenix area, including redefining the emissions-to-visibility "transfer coefficients" to a proportionality method which attributes secondary species (PM nitrate) to the emissions inventory contribution. (An example of this method might be a reduction of 50 percent PM nitrate due to 50 percent reduction in nitrate-precursor NOx emissions).

WSPA is concerned that the modified IAS method is fundamentally flawed. The concern derives from:

- The assumption that PM nitrate reduction is proportional to NOx emissions reductions. It is well known that NOx emissions and SO2 emissions compete to form PM. In an ammonia-limited atmosphere, ammonium sulfate is preferentially formed, limiting ammonium nitrate production.

  Furthermore, twice as much ammonium is needed to form ammonium sulfate as ammonium nitrate. So where ambient NOx is abundant, reduction of sulfur dioxide emissions alone can double the ammonium nitrate production and reduce visibility.

  These concepts point to caution that must be exercised when specifying emissions control strategies. Without informed decision-making, increases in PM and worsening visibility could result. Using the best science to study PM dynamics best informs decision-makers.

- The assumption that PM nitrate is proportional to only the one precursor species emissions. Recent science has found PM nitrate to be particularly sensitive not just to precursor NOx or NH3 emissions, but to VOC emissions as well[1][2][3]. Simplistically, the concept is based on the rate of wintertime ozone production—hence the need to perform comprehensive modeling of all precursors in a "one atmosphere" approach.

- The assumption that measured PM at any one site is representative of contributions from emissions domain-wide.

WHETHER RELYING ON SPECIATED MEASUREMENTS ALONE OR RELYING ON RECEPTOR MODELING RESULTS, THE REPRESENTATION OF PM PRODUCTION SPATIALLY IS NOT

[1] Pun, et. al. 1999. *Sensitivity of PM Nitrate Formation to Precursor Emissions In the San Joaquin Valley.*
[2] ICF Consulting. 1999. *Air Emissions Analysis of San Joaquin Valley Enlightens Pollution Control Strategies: CONSULT.*
[3] Morris, R. 2000. Personal Communication regarding October SCAQS Episode PM Application.

UNDERSTOOD IN ANY AIRSHED UNTIL IT IS MODELED. THE SPATIAL REPRESENTATION OF PM PRODUCTION IS CRITICAL CONSIDERING THE GOAL OF THE BROWN CLOUD STUDY—EMISSIONS REDUCTIONS WHERE VISIBILITY IMPROVEMENT IS MOST NEEDED. THUS, APPORTIONING EMISSIONS THROUGHOUT PHOENIX, USING GRIDDED SURROGATES, WILL BETTER CHARACTERIZE PM PRODUCTION AND VISIBILITY DEGRADATION, AND CONSEQUENT CONTROL STRATEGIES' EFFECTIVENESS.

WSPA asserts that regional grid modeling of Phoenix PM precursor emissions is the best science-based approach to determining the visibility impacts due to any source category.

Several PM models and modeling tools are available and are currently used to determine visibility impacts and source attribution. We suggest using the ADEQ PM emissions inventory as a basis for developing a gridded modeling inventory to be input to the CAMx model or UAM-AERO. Ongoing development of CAMx and improvement of UAM-AERO have been funded by both the American Petroleum Institute and the Coordinating Research Council. Environ, a recognized, qualified air quality consultant, has estimated the application of these models in the Phoenix airshed could cost $100,000 and take 6 months to complete.

Comments On The Gasoline/Diesel Split In The Emissions Inventory

There is tremendous uncertainty with respect to the estimated contribution of gasoline and diesel vehicles to Phoenix PM which is not reflected in the Brown Cloud Summit draft report. The "bottom-up" emissions inventory projects that diesel vehicles are the primary source of motor vehicle PM, while the chemical mass balance (CMB) approach estimates, based on ambient data, indicate that gasoline vehicles are the primary source of motor vehicle PM. This difference alone underscores the tremendous uncertainty with respect to the estimated contribution of gasoline and diesel vehicles to Phoenix PM. In WSPA's view there is uncertainty in both forms of emission estimation, inventory and CMB which is underscored by the large difference between the two methods. The Brown Cloud report should document the large uncertainty in the source contribution estimates.

The tremendous uncertainty with respect to the estimated contribution of gasoline and diesel vehicles means that the visibility projections are also very uncertain. This uncertainty, as well as the many other uncertainties regarding the Brown Cloud issue, should be - but are not - reflected throughout the Brown Cloud Summit report.

Comments On The Use Of Mobile Source Model Predictions For Ambient PM, Sulfate and Nitrate Production

Unfortunately, we haven't had time to investigate this issue more thoroughly, so it is posed below as a question.

The EPA PART5 model was used in the Brown Cloud Study to estimate PM emissions from mobile sources. The EPA PART5 PM mobile source emissions model reports direct (exhaust) and indirect (secondary) sulfate as a result of SO_2 emissions. Nitrate (NO_3) is not treated at all. The model-predicted secondary sulfate emissions option is a default estimate that assumes proportionality between

sulfur dioxide (SO_2) emissions and subsequent sulfate using a nationwide average sulfate conversion factor (i.e., 12%). No chemistry is used to derive the secondary sulfate "emissions".

PM air quality modelers usually ignore the secondary sulfate "emissions" estimates provided by PART5 and use only the primary sulfate and the sulfate precursor emissions for input to PM grid models for an ambient sulfate prediction. The grid model numerically simulates the PM chemistry temporally and spatially. It is not clear how the PART5 secondary PM is treated in the modified IAS.

The ADEQ control strategy summaries cites sulfate and nitrate reductions, which leads us to believe these reductions were estimated explicitly using a PM emissions analysis compiled by a contractor "MathPro", who used Maricopa county emissions changes as derived in another contractor's—"Energy and Environmental Assessment (EEA)"--report. MathPro retained the PART5 sulfate conversion estimate and assumed a 2% conversion rate to nitrate, admittedly with little justification.

Consequently, MathPro's use of PART5 sulfate and the assumption of nitrate conversion numbers are not only incorrect from a modeling chemistry standpoint, but the concept results in an apples and oranges tonnage comparison with other control strategies. Depending on how the nitrate and sulfate results were used, ADEQ could be overestimating vehicle fuels PM benefits.

That is, there is a potential inconsistency where the ADEQ PM emissions results include secondary sulfate and nitrate, yet reductions in ambient secondary nitrate and sulfate concentrations are also assumed to be directly proportional to the reductions in NO_x and SO_2 emissions. This may result in double-counting of impacts or benefits. Therefore, we pose the question, how were the PART5 results used in the modified IAS?

ATTACHMENT II

Emission Credit Trading Program

In areas with air quality problems, the primary goal of emission control programs is to reduce emissions by the amount necessary to achieve desired air quality targets at the lowest possible cost. Traditionally, the approach to achieving this goal has involved the analysis of the costs, benefits, and cost-effectiveness of a suite of specific emission standards or emission reduction requirements that would apply to specific emission sources. Once this analysis is completed, the most cost-effective combination of control measures required to meet air quality targets can be selected for implementation. This type of strategy is frequently referred to as the "command and control" approach.

Emission reduction credit trading programs such as the South Coast Air Quality Management District's "Reclaim" program for NOx emissions represent an alternative to the command and control approach. Under this strategy, an emissions budget is established for sources in an area that are then provided with emission "credits" equal to that budget. Sources with emissions that are lower than the budgeted amount have surplus credits that can then be sold or traded to sources with emissions that exceed their budgeted amount. To assure a reduction in overall emissions, the total emission budget for the area is reduced over time and all sources in the program in the area have the option of either reducing emissions or obtaining adequate credits.

In theory, under a credit program of this type, control equipment is installed on those sources where it is most cost-effective to generate surplus credits. These credits can then be sold at some profit to those sources where control is less cost effective, at a cost that is still less than the cost of control. The theoretical result is then cost-effective emission control for the area through the application of market forces rather than traditional regulations.

While emission reduction credit trading programs represent what may be an appealing market-based alternative to command and control programs, they must be carefully implemented in order to assure that they achieve real emission reductions and improvements in air quality without causing adverse economic impacts on either the sources subject to the program or on the governmental agencies responsible for operating the program.

The first step in the development of a credit program is establishing the pollutant or pollutants to which it will apply, the emission reduction targets and air quality goals, as well as the types of sources that will be included in the program. Although this may seem straightforward, a number of complicated issues can be involved. For example, if the air quality goal is related to visibility improvement, then the first issue is identifying those pollutants to be included in the program and assuring that reductions in emissions of those pollutants in the program area will result in measurable improvement in visibility. Next, a quantitative means of relating emission reduction of different pollutants (e.g., direct PM emissions versus species that result in secondary PM, such as NH_3, NOx, SOx, and hydrocarbons) to improvements in visibility must be established. After that, a visibility improvement target needs to be set and a relationship between that target, the required emission reductions, and the time frame over which the target is to be met must be determined.

Once the issues discussed above have been addressed, the next question is determining what sources should be included in the credit program. While it would seem logical to include all sources of emissions (e.g., mobile, stationary, and area sources), this may not be practical given the need to establish accurate emission budgets, and accurately quantify actual emissions. In general, quantification of emissions is relatively complex and involves extensive record keeping and, in some cases, continuous emissions monitoring, which is considerably more difficult for area and mobile sources than it is for larger stationary sources. The difficulties for area and stationary sources arise from the fact that they are much more numerous and their activity is more difficult to record.

There are also additional complications associated with the inclusion of mobile sources into credit programs. First, mobile sources are subject to new vehicle emission standards established by the federal government that become increasingly stringent over time. It is unclear what if any rationale could be established for including reductions from new vehicle standards into a credit program. This factor has to be taken into account in any of the most popular types of mobile source credit strategies such as early vehicle retirement, repowering or retrofit of heavy-duty vehicles, conversion to alternative fuels, etc. Another important factor is that mobile sources such as heavy-duty trucks and construction equipment may frequently operate outside the boundaries of a credit program area and it would therefore be improper to provide credits for such operation.

Returning to the economic aspects of a credit program, it should be apparent that program operation will impose a substantial administrative burden on both the sources included in the program as well as on the governmental agencies responsible for the program. In addition, fluctuations in the market value of credits may create economic issues. For example, if a company defers installation of

control equipment in favor of purchasing credits on the open market, and credits then become either very expensive or unavailable, the company may experience substantial financial hardship or could conceivably be forced out of business depending on the detailed requirements of the credit program.

ATTACHMENT III

Comments On Arizona Department Of Health Services (ADHS) Presentation On Particulate Matter (PM)

General Comments

The ADHS presentation conveys that the health effects from exposure to particulate matter (PM) are definite and easily quantifiable. In fact, there is much uncertainty in the health effects presented by ambient PM and quantification of the risks. For this reason, Congress mandated and has funded for the last 3 years a comprehensive research program to explore the health effects of PM. The total cost of the 10-year program, outlined by the National Academy of Sciences, is estimated at approximately $400 million.

Chart 1

PM 0 to 10 has been "consistently" associated with**:...**

The data on PM are less than consistent. For example, different authors studying the same city (e.g., Steubenville OH, Chicago IL, Utah Valley, Philadelphia PA, Birmingham AL) have come to completely different conclusions concerning the correlation of mortality with PM exposure; some report positive associations, some report no associations. (See later comments on studies in Phoenix).

The key study used by the USEPA in establishing its proposed 1997 fine particulate NAAQS is known as the ACS study. A study team funded by the Health Effects Institute (HEI), which is in turn partially funded by the USEPA, recently reanalyzed this study. Part of this reanalysis included a sensitivity analysis to examine if alternate risk models that included additional covariates (e.g., demographic, socioeconomic, climatic and environmental factors) **NOT** considered by the original investigators, confounded the calculated associations with PM. Indeed, inclusion of a number of covariates, including sulfur dioxide, other gaseous pollutants, education level, population change, unemployment, number of hospital beds, temperature, temperature variation and altitude reduced the estimated relative risk of PM. For example, when sulfur dioxide was included in the statistical model, the mortality attributed to fine PM and sulfate were markedly reduced for all but one analysis (the model used by the original investigators) to statistically insignificant levels. **This one analysis alone brings into serious question the use of risk estimates derived from the ACS study for application to areas where sulfur dioxide levels are low (e.g., Phoenix).** When all gaseous pollutants were included in the model, the relative risk attributed to PM was 1.00 (i.e., no risk). The fact that various socioeconomic factors, particularly education level, had a strong apparent association with mortality argues these factors were not adequately addressed in the original investigators report. **Overall, the reanalysis raises serious**

questions about using this study to perform quantitative PM risk assessments (e.g., to predict with any certainty the mortality rate associated with the level of ambient PM).

It should be noted that the incidence of deaths from respiratory causes noted in slide one was not even reported in the original ACS study.

Chart 2

PM 0 to 2.5 appears to be more damaging because:

The smallest particles are inhaled deeper into the lungs
The smallest particles are more difficult to remove from the lungs

We agree conceptually that smaller particles are inhaled deeper into the lungs and can be harder to clear from the lungs (first two bullets). However, larger particles depositing in the upper airways are also associated with health effects. For example, bronchitis is a disease of the upper airways. Concerning the PM_{10} versus $PM_{2.5}$ epidemiology data, there are many more epidemiology studies associating PM_{10} with health effects. For this reason, a number of scientific and regulatory authorities believe measurement and control of PM_{10} provides health protection (e.g., recent decision by Scottish expert panel on air quality to continue regulation of PM_{10} versus $PM_{2.5}$).

- The particles are often from combustion sources (i.e., diesel exhaust)

While it is estimated that between 40-60% of $PM_{2.5}$ is derived from combustion sources, diesel exhaust PM is a relatively small source of the total ambient PM. The best estimate of population exposure to diesel PM is 1-2 ug/m^3 (CALEPA) or less than 10% of the ambient fine PM.

- Particles from combustion are more toxic

More toxic than what???

- Particles from combustion are likely to be carcinogenic

The data on this topic are controversial and inconclusive in nature. The two main studies in the U.S. that have evaluated the carcinogenic effects of ambient PM are the ACS study (described above) and the Harvard 6-Cities study. The Harvard 6-Cities study did **NOT** report an association between lung cancer and exposure to ambient PM while the ACS study did report an association. Again, this argues against the ADHS' consistency claim. The PM metric associated with lung cancer in the ACS study was sulfate PM; fine PM was not associated with lung cancer. This in and of itself is not plausible, since sulfate particles are water soluble and cleared readily from the lungs while fine PM would be more likely to have PNAs and organic materials of potential interest from a carcinogenicity perspective. In the reanalysis study mentioned above, when occupational exposure to PM was more adequately controlled, the cancer risk originally reported disappeared! So, the data supporting the statement above are less than convincing.

Chart 3

As described above, the data supporting the accuracy of the risk estimates presented in this chart are highly speculative and uncertain. In addition, it is interesting to note that the annual average PM_{10} level

in the Phoenix area is **below** the annual PM_{10} standard of 50 ug/m^3 and the value for the worst 20% of 35 ug/m^3 is well below the 24-hour standard of 150 ug/m^3. Even the most polluted day of the year value of 120 is below the 24-hour standard. One could argue that the air quality in Phoenix is well within the national standards. This brings into question the concept of calculating imaginary serious health effects endpoints when exposures are below the standards. Since the USEPA just reviewed the science and set this standard (now remanded), it seems inappropriate to talk about risks below the standards.

Studies of Air Pollution in Phoenix, Arizona

It would seem more relevant to consider studies of the effects of air pollution in cities or areas in Arizona rather than general exposure response curves derived from analysis of cities in other states such as reported in the ACS study. We are aware of three studies of the effects of PM air pollution in Arizona. In the first study, Shreffler et al. performed multiple and random permutations to examine how such multiple testing can influence PM/mortality association using air pollution data for Phoenix.[1] They reported a small risk attributed to **coarse** particle exposure in Phoenix while **no association was observed between fine PM mass and mortality.** They deemed that the above reported associations are unreliable. They conclude that their results illustrate how the commonly used approach of using random permutations of the morality data and alternate variable selection in currently performed air pollution epidemiology studies can lead to over-interpretation of the significance levels attributed to mortality/PM associations.

In a recently reported study, air pollution and daily mortality in Cook County IL, Los Angeles County CA, and Maricopa County AZ were investigated.[2] In general, **the author concluded that ambient gases were more important in mortality associations than PM and the recent emphasis on PM appears misguided. In Maricopa County there was no evidence of any association of particulate matter (PM_{10}) with respiratory (COPD) mortality.**

In another recently reported study, the effects of air pollution on hospital admissions for diseases of the circulatory system in three U.S. metropolitan areas, including Maricopa County, were investigated.[3] In Maricopa County, the gases, with the exception of ozone, were weakly associated with hospital admissions for cardiovascular disease, while **no associations were observed for PM.**

<u>References</u>

[1]Shreffler, J., Smith, R., Davis, J. (1997). An Initial Search for Association between Particulate Concentrations and Daily Mortality in Phoenix.

[2]Moolgavkar, S. (2000). Air Pollution and Daily Mortality in Three U.S. Counties. Environmental Health Perspectives 108: 777-783.

[3]Moolgavkar, S. (2000). Air Pollution and Hospital Admissions for Diseases of the Circulatory System in Three U.S. Metropolitan Areas. Journal of the Air and Waste Management Association 50; 1199-1206.

<u>Chart 4</u>

It is important to emphasize the ideas listed in the third and forth bullets rather than the sensationalistic quote in bullet one. The important points are as follows:

The USEPA's Clean Air Science Advisory Committee (CASAC) view is: 1) there is inadequate evidence to establish a **causal** relationship between exposure to diesel PM and cancer, and 2) the uncertainty in the diesel exhaust data make it impossible to derive, with any confidence, quantitative estimates of cancer risk.

Chart 5

Since OEHHA believes it can derive quantitative estimates of cancer risk of exposure to diesel exhaust using available data, its scientists either: 1) are smarter than the CASAC scientists; or 2) had better data to consider; or 3) care less about all of the uncertainty. We do not consider the scientists at OEHHA to be more informed than those on the CASAC and both the USEPA and CALEPA risk assessments consider the same data. So, it is our view that CALEPA is less concerned about all of the uncertainty.

There are several concerns with the epidemiological data used by CALEPA to derive the quantitative cancer estimates. All of the diesel exhaust epidemiology studies used inadequate or indirect measures of exposure resulting in significant exposure misclassification. In addition, many of the studies were confounded by exposure to other known lung carcinogens, e.g., tobacco smoke. For these reasons, the current data are considered inadequate for assessing the carcinogenic potential of diesel exhaust. For this reason the HEI has initiated a large-scale epidemiology study to evaluate the potential carcinogenicity of diesel exhaust. Until such data are available, our view is that the OEHHA quantitative risk estimates are not reliable.